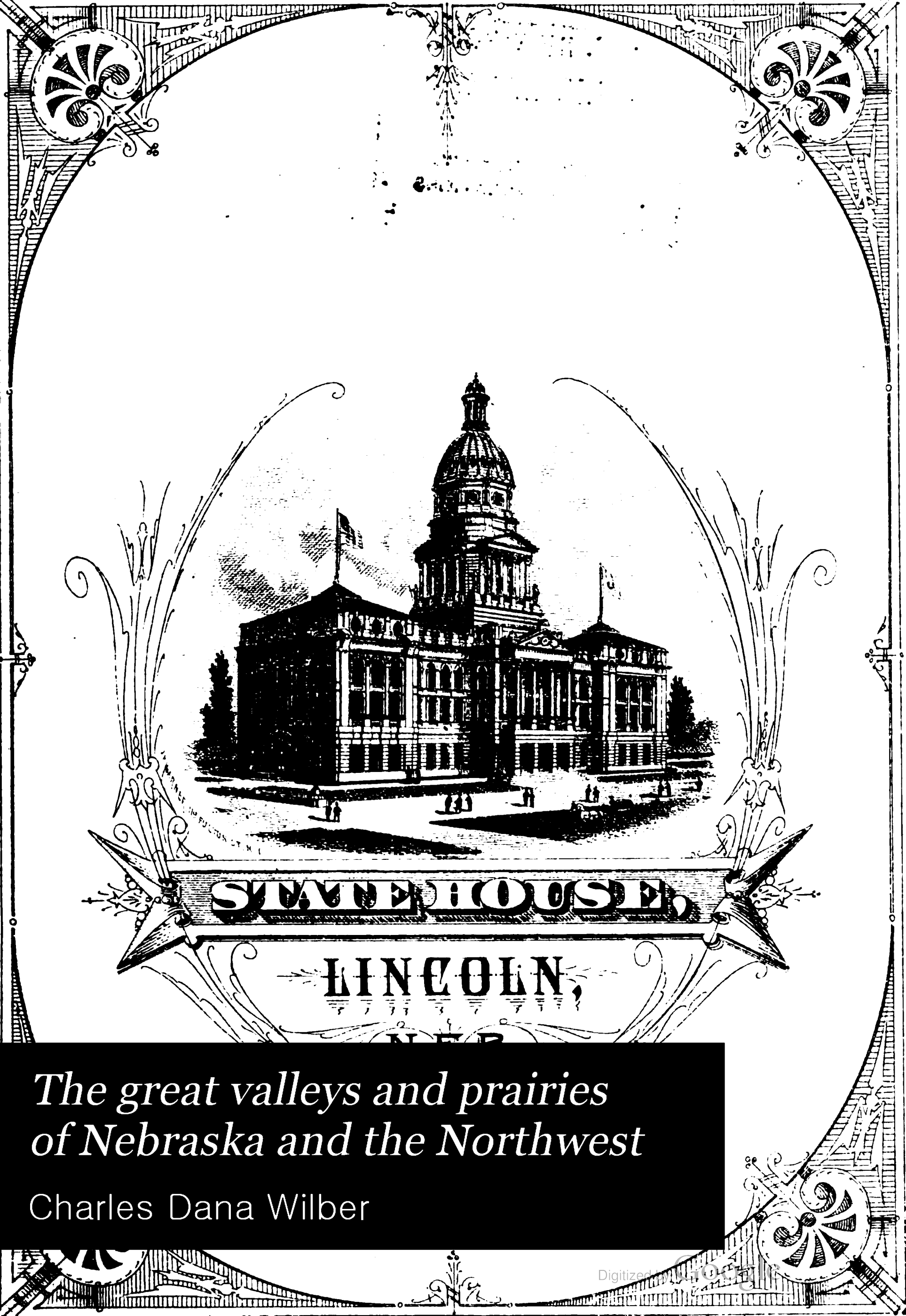
STATE HOUSE,
LINCOLN,

To H. H. Van Liew
with the author's regards
C. D. Wilber

THE

GREAT VALLEYS AND PRAIRIES

OF

NEBRASKA

AND THE

NORTHWEST.

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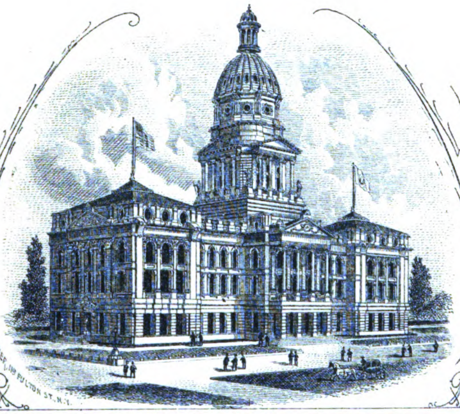

STATE HOUSE,

LINCOLN,

NEB.

PREFACE.

THIS volume is intended to answer many questions in regard to that part of our country being and lying west of the Missouri River—but more especially Nebraska, Kansas and Colorado.

In preparing this work the writer has endeavored to accomplish two purposes: First, to assure those who have already begun their homes in the region beyond the Missouri River, that its natural resources and attractions are second to none in the Middle and Eastern States; and, second, to convince those especially who are seeking homes and farms, or business and health, of the substantial facts that should determine a good investment.

So many contradictory statements from persons of position have, within the last ten years, been published concerning the future industries of the States and Territories west of the Missouri River, it has been deemed by the writer most important to clearly set forth the evidence of the agricultural ability of the country west of the 100th meridian, and to this end considerable space has been devoted.

It has so long been the practice of Western writers to describe only such matters as readily occur to superficial observation, viz.: charming scenery, statistics of progress, inventories of products, etc., etc., that the public, well posted in these commonplace catalogues of prosperity expressed in bushels or dollars, have a desire for a deeper knowledge of the physical basis and security of these unerring tokens of prosperity.

Some of the topics presented in this volume—the future of our national domain, the laws of farm-making, the glacial and geyser agencies, the water system, the soil—its origin and varieties, the origin of the prairies, sources of moisture and increasing rainfall, system of topography and drainage—are of such practical type as cannot fail to greatly interest all classes of citizens.

The geology of the 40th parallel is intended to give for Nebraska, Kansas, and Eastern Colorado a practical view of the order and succession of the rocky strata in each State traversed by said parallel, with brief condensed descriptions of such natural values as occur. The Government work, by Clarence King, followed the 40th parallel west from the vicinity of Denver to the Pacific Ocean, leaving the distance, 600 miles, to the Missouri River an unexplored region. It is hoped the chapter on geology will in some measure supply the deficiency.

He who distributes or popularizes knowledge, says Bacon, is as useful as he who originates or discovers. And while this is attempted, the deeper purpose of this volume is to dismiss, in some manner or degree, the gross ignorance that pervades the great mass of Eastern people concerning the actual physical condition and agricultural ability of the trans-Missouri region.

The author is greatly indebted to Prof. Samuel Aughey, of the State University. For a period of 18 years, without a peer or predecessor in his favorite pursuits, he has been the able explorer in every department of science. To him, from the savans of both Europe and America, is cheerfully accorded a place in the front rank of living naturalists. From his recent work, viz.: "Sketches of the Physical Geography and Geology of Nebraska," with permission, frequent and copious extracts have been made. The extended description of the great

Valley of the Niobrara river, and its attractions for farming and herding, with analyses of soils, recently prepared by Prof. Aughey, is a valuable contribution to our knowledge of Northwestern Nebraska.

As aids in understanding the gigantic effects of both glaciers and geysers, in producing the physical features and conditions of the West, it was deemed proper to describe their actual operations in the more distant regions of our country.

The lesson models for the systematic study of the Physical Geography and Geology of Nebraska are intended to supply a want often expressed by the leading educators of the State. The six forms adapted to school uses, have been prepared with care, and tested by experience. This volume, with the work of Prof. Aughey, already referred to, will supply most of the information required in their use.

The subjects herein considered have an inevitable bearing upon Western immigration.

For nearly two centuries in the history of our country the West has been the golden realm for new and successful enterprise. In periods of financial depression our people have received, more than from all other sources, renewed strength and vigor from the West.

As—when at sea, a ship-of-the-line has been passing through a protracted storm, and all on board are weary, and some despairing, it is most natural to look towards the western horizon for signs of better days—so, the great West, with its marvelous resources, undeveloped yet well assured, with its mighty possibilities looming up in the near distance like its own mountain summits, gives such earnest promise of the prosperity and per-

our country, that I gladly invite the reader's attention to this cheerful inventory of wealth and peace.

...he "prairie schooner" or emigrant wagon, and the ...comparison is stronger than contrast; both take ...westward guided by the Star of Hope, and both ... scanty outfit upon an untried voyage. For one ...cross the stormy sea; for the other, across the fixed ...slopes and divides of the limitless prairie; in the ...cabin, the prayer for safe guidance in search of ...nd free, was not more earnest, or honest than the ...tition for strength and wisdom from the same un-... Each, alike, meets and overcomes the opposing ...group and family select their land and build according ...means and tastes—whether on Plymouth beach, or ...ie valley of the Great West.

...of their hands is the same, with same reward—...ith the same purpose and energy, in due time, rises ...use, and the church with Heaven-pointing spire.

C. D. W.

...arch 4th, 1881.

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The Great Republican Valley.

CHAPTER I.

Position and Comparative Area—The Republican River and its Tributaries—Prairie Dog, Sappa and Beaver Creeks—The Driftwood—Forks of the Republican—The Arickare—Frenchman's Fork, Waunita Falls—Blackwood—Big Timber Creek—Red Willow—Big Medicine, Etc.

THE valley of the Great Republican River occupies a large area central in the American Republic, and comprises considerable portions in Southern Nebraska, Northern Kansas and Eastern Colorado.

From its union with the Kaw River, at Junction City, Kansas, its course extends northwest 100 miles through a somewhat narrow valley, not exceeding 15 miles in width, to Superior, on the 40th parallel, where it enters the State of Nebraska.

Its direction from this point bears mainly west, with bends and flexures for 260 miles and reaches the eastern boundary of Colorado at the 102d meridian.

The area drained by this river and its many tributaries lies between parallels of 38° and 41° N. latitude, and of longitude 97° and 105° west from Greenwich. The immense territory included within the water-shed of the main stream and accessories is more properly a basin or plateau, widening towards the west, and contracting into a neck towards its eastern outlet, its narrowest portion being the last 100 miles of its course from the Nebraska State line to Junction City, Kansas.

Its entire length, following its winding course, exceeds 500 miles, viz.: 100 miles in Kansas, 260 in Nebraska, and 150 in Colorado.

It has several important tributaries from the southwest: 1st, the Prairie Dog, 150 miles in length; 2nd, the Sappa, 140

miles; 3d, the Beaver, 138 miles; these have their rise near the sources of the Solomon and Smoky Hill; 4th, the Driftwood, 80 miles in length, noted for its extraordinary supply of timber and stone; 5th, 6th, and 7th, Rock Creek, Arickare and Republican Fork unite with the main stream near the western limit of Nebraska; their length has not been definitely stated, but they drain a large area of homestead lands; 8th, Frenchman's Fork rises in Colorado near the Platte, and has its course southeast through the southwestern portion of Nebraska; it is 90 miles in length; 9th, Red Willow, wholly in Nebraska, 75 miles; 10th, Medicine Creek, also 75 or 80 miles in length.

A Kansas writer remarks: "It is the largest river of the plains, and drains a broader area of the homestead lands than any other." The branches above enumerated, each with its suite of smaller creeks and valleys, form the drainage system of a district containing many thousand square miles.

Says Dr. Latham, in 1874:—"The Republican Valley, southwest from Fort Kearney to the sources of the Republican River east of Denver, is 250 miles long and 100 miles wide—a region half as large as England.

"It is diversified with plains, bluffs, and valleys. Not a rood in its sixteen million acres but is the finest of grazing, with a luxuriant growth of blue, buffalo and bunch grasses.

"It is well watered by the Republican River and its nineteen tributaries, which with their feeders intersect this whole basin.

"No streams on the plains compare with these for timber. On their bottoms are groves of whiteoak, ash, cottonwood, and elm. The average width of the main valley is nine miles. The smaller streams have narrower bottoms, but they all abound in grass. So do the divides between, but with other varieties.

"The altitude of the Republican River is much lower than the Platte, and it is therefore much warmer. Its mean annual temperature must be 53° F. The annual rainfall is 18 inches,—the snowfall about 20. There is timber enough for building and

fencing. Limestone outcrops in all the valleys. Winter grazing is equal to any in the world."

Besides these there are on both sides, but more especially from the north, many streams of local importance, varying from 25 to 50 miles in length. With few exceptions they are mill streams, fed by innumerable springs, and maintain a flow nearly uniform during the year.

The narrowest portion of the Republican Valley in Nebraska is found in Nuckolls, Webster and Franklin counties, where the distance across from the Platte to the Solomon does not exceed 40 miles. But in Harlan and Furnas, as the larger tributaries gradually converge, the valley expands to a width of 80 miles. Along the 100th meridian it is 100 miles in width.

Through Red Willow County, north and south, its width is 110 miles. Through the county of Hitchcock, following the State line, it is 125 miles. Its greatest expanse or width in Colorado, from a point near Julesburg to the Arkansas divide, is nearly 140 miles. Its western rim is determined by the course of the South Platte, Beaver, Bijou, and Big Sandy, shaping its watershed into the form of a huge semicircle.

The area in Nebraska, within the basin of the Republican, is as follows:

Nuckolls	**County,**	**9**	**Townships.**	**Dundy**	**County,**	**24**	**Townships.**
Webster	"	12	"	**Phelps**	"	8	"
Franklin	"	12	"	**Gosper**	"	9	"
Harlan	"	16	"	**Frontier**	"	28	"
Furnas	"	20	"	**Hayes**	"	20	"
Red Willow	"	20	"	**Chase**	"	24	"
Hitchcock	"	20	"				

In Northwestern Kansas, the area included in the Valley is as follows:

Jewell	**County,**	**10**	**Townships.**	**Rawlins**	**County,**	**30**	**Townships.**
Smith	"	10	"	**Thomas**	"	15	"
Phillips	"	10	"	**Cheyenne**	"	30	"
Norton	"	15	"	**Sherman**	"	24	"
Decatur	"	30	"				

To these add 2,000 square miles for its area in Republic, Cloud, Washington, Clay and Riley counties, Kansas; and allowing for half-townships and the vague character of divide lines, the area of the Republican Valley in the State of Nebraska is nearly 6,200 square miles; in Kansas, 8,500; in Colorado, 1,300; total, 27,200; exceeding in size one-half the State of Ohio, and larger than all the New England States. At its mouth (Junction City) its elevation above sea-level is 1,100 feet. The following table of altitudes shows its general inclination from said point. The estimates are barometric and have been used in public surveys:

State line (Kansas)	1,500
Red Cloud	1,676
Riverton	1,770
Bloomington	1,930
Republican City	1,986
Alma	2,018
Orleans	2,150
Arapahoe	2,250
Indianola	2,600
Culbertson	276
Head of the Republican in Colorado	4,050

The main River has a descent of 7 feet per mile in the lower half of its course. The tributaries and the upper portion of the river are generally more rapid, caused by the more abrupt lines of drainage in approaching the various sources near the great divides.

From the river bed, north and west, the inclines are long and gradual, terminating upon an even plateau. Towards the south the slopes are short and broken by innumerable intervals, with steep and often precipitous sides—a result which relates in part to the direction and force of glacial action, and partly to the decided outlines of a still more ancient topography.

The *Prairie Dog*, *Sappa*, and *Beaver creeks*, from the south, are the most important tributaries of the Republican River. They all have their rise near the Colorado line in North-western Kansas, emanating, doubtless, from the deep-

seated sands that now appear to be the source of the wonderful water-system of this great central basin of the continent.

Each of these streams traverses and drains nearly the same area, and is accompanied with very similar physical conditions of rocky basis, surface, soil and subsoil, timber groves and stone-quarries. Already are they occupied nearly to their sources with new farms.

The convergence of streams whose sources are widest apart indicates the common centre of the upper basin of the Republican Valley to be at or near Culbertson. It is the drainage-centre for several large streams, viz., the Driftwood, Blackwood, and Frenchman's Creek—the main stream here bearing to the South-west, and keeping this direction to its source near Cedar Point, 90 miles east of Denver.

Prof. Aughey, however, describes a large hydrographical basin, traversed by the South Fork of the Republican in Colorado, which he indicates by barometric altitudes. He regards it as the area once occupied by a great inland sea, on whose low, retreating shores gathered in droves the huge mammalian forms whose remains are so abundant.

The Driftwood has a length of 60 miles, and bears northeast. It is a rapid stream, in a close valley, diversified with large groves of timber and ledges of rock. These are so interspersed as to give nearly every quarter-section extra value. This series of rocks are of the Pliocene tertiary. As yet no quarries have been opened, but it is evident that this material can be easily wrought.

The stream generally lies deep within the banks, and, though very tortuous, can be easily and cheaply bridged. For many miles on either side the prairies, with winding stream, rocky ledge, large groves and varied upland, form charming groups of scenery in this secluded corner of the State.

Frenchman's Creek—or Fork, as it is usually called—is over 100 miles in length. Thirty miles above Culbertson it receives Glenn's Creek (called sometimes "Stinking Water" from Indian tradition,) from the northwest. Its course is meandering to and fro across bottom lands of considerable width, well fur-

nished with groves of timber, mainly cottonwood, with cedar in the side canons. The bluffs flanking the bottoms are of a moderate type, easily receding to the rolling uplands, that present the same evidence of fertility observed in Eastern Nebraska. Waunita, or Wauneta Falls is 50 miles above Culbertson. It is in the southeast corner of Chase county, with rapids above of 10 feet or more and a fall of 8 feet over a ledge of the Fort Pierre group, escaping with quick descent. It is the most charming spot in Southwestern Nebraska. The amount of water is sufficient for half-a-dozen mills.

It now idles itself away to its own music. But Nature made it for use as well as beauty, and soon enough it will take on the drudgery of machinery. The bluffs near by, with buttes like the ruined foundations of some feudal castle, give back many echoes, and fill the air with charming undertone of melody. It calls to mind Irving's description of the Alhambra: "Such is a faint picture of the moonlight nights I have passed loitering about the courts and halls and balconies of this most suggestive pile, feeding my fancy with sugared suppositions and enjoying that mixture of reverie and sensation which steal away existence in a Southern climate, so that it has been almost morning before I have retired to bed and been lulled to sleep by the falling waters of the fountains of Lindaraxa." Above Waunita the bluffs wholly disappear in the gradual sweep of rolling prairie, and this type of surface is maintained for many miles beyond the Nebraska border, in Colorado.

The Arickare.

This stream flows into the Republican about six miles east of the west line of the State. At this point the Arickare is about thirty feet wide. Except after rains the water is clear and pure. Occasionally it is rapid, and rarely sluggish. Over a large part of its course it flows over a rocky bottom. It is larger than the main channel of the Republican. From its mouth to its source it is over one hundred miles long. The character of its bottom,

adjoining bluffs, and uplands is somewhat different from that of the Republican. In its lower half the bottoms are not so wide, narrowing often to less than one-fourth of a mile, and again widening out to more than treble that size. The bluffs bordering the plains are sometimes composed of rocks of Pliocene age, underlain by deposits of the Fort Pierre cretaceous group. The softer rock underlying the silicates of lime at the top have in places been worn away, leaving shallow caverns. Lateral canons also often come in, adding much to the rough character of a few sections along this drainage system. To make amends, however, for this peculiarity, nature has clothed the bottom with timber. There were here, at least formerly, fine groves of ash, elder, cottonwood, elm, an occasional oak, and a few other trees. The needs of the herders, however, have long since commenced a rapid diminution of this timber supply. Some few of the groves, in sequestered canons, will be perpetuated because of the difficulty of access. In the upper part of the valley, and especially towards the sources of the Arickare, the bluffs become lower and gradually shade into the great Colorado plain. In many places along the river, springs of water of delicious freshness make their appearance and greatly enhance the value of this basin.

As in so many other places outside of the flood-plain of the valley, the land is exceedingly various in form and character. The superficial observer would claim that it did not differ from any other portion of the basin. A close study, however, reveals some exceptional features. In places the uplands are gently rolling, with a black surface soil, underlaid by loess or modified loess. In other places the soil is composed principally of drift materials rich in the alkaline earths. The sandy tracts, however, vary most in character. Some of these are composed of partially coarse materials, and though now grown over with a sparse covering of coarse grasses, will probably need to be fertilized in order to become remunerative farming lands. Other sandy tracts are remarkable for the microscopic fineness of the soil, and are so mingled with organic matter and alkaline earths as

will make them at once productive when brought under cultivation. On the whole, there will be little waste land here when once the advancing wave of settlements occupies this basin. The few excessively sandy tracts will be utilized for pasture lands, and the rough canons and steep bluffs will prove admirable for sheep pasturage and forest-tree culture.

There is great advantage in having some rough land in a district. It prevents for a long time too much crowding; it leaves a breathing spot for society, where the wild flowers can be perpetuated, and the land reconsecrated to the uses of nature. Cultivated fields are beautiful, but the sight becomes tame unless relieved by some of nature's original productions.

Forks of the Republican.

In approaching the Forks of the Republican, the bottoms widen out and shade more or less into the uplands. The upland bluffs are composed in part of loess, and in part of exceedingly fine sand, and these two characteristically distinct deposits in this region shade into each other. At and near the Forks, the sands are conspicuous, and have crept down more or less to the bottoms. They are here exceedingly fine, and seem to be little more than loess with the finer and more impalpable material removed. The following analysis, by Prof. Aughey, of about an average specimen seems to prove this:

Insoluble siliceous matter,	83.01
Ferric oxide	3.02
Alumina	.05
Lime carbonate	5.11
" phosphate	2.99
Magnesia carbonate	1.87
Potassa	.91
Soda	.99
Organic matter	.60
Moisture	.90
Loss in analysis	.55
Total	100.00

It will be seen that these sandy tracts differ but little from true loess. They vary from them principally in containing a trifle more silica and considerably more alkaline matter, especially carbonate of magnesia, potash and soda, and slightly less organic matter and alumina. Their composition, however, is such as only requires proper cultivation and moisture to make them valuable agricultural lands. From the above soil there is a shading on the one hand into distinct loess, and on the other hand to an occasional deposit of coarser sandy material.

Big Timber Creek.

A few miles above the Forks on the south side of the South Fork, is the site of an old ranche now fallen into decay. It was kept by a character, noted in his day named Biefield. A fine spring at this point, no doubt, was the inducement to establish his ranche here. He was supposed to be engaged in the fur trade with Indians and trappers, and to retail to them groceries, whisky, and other luxuries of frontier life. More knowing ones, however, insisted that his principal business was horse-stealing and harboring horse-thieves. However that may be, many curious stories are told of unlawful transactions at this old ranche, and eventually it became so hot for him that he took refuge in Canada.

Near this old ranche of Biefield's is the mouth of a creek, which is now known as Big Timber Creek. It is in range 37 west, and near the Kansas line. It comes from a direction a little west of south. Going up this creek I found the bottoms to range from one-fourth to two miles in breadth, interrupted, however, by several low terraces of easy ascent. The lower bottom was mainly covered with cottonwood timber which in places crept over the first and second terraces. Some elder, elm, and willows were in places mixed with the cottonwoods. A few groves of plums were also encountered. The timber extended up the valley for nine miles, and scattering trees were common still farther. A noticeable feature of the timber was that nearly all the trees were old or mature, and few young groves

were starting to take the places of the old. One old tree, lying on the ground, that had a section sawed off, had at least one hundred and twenty rings, showing that it had been growing for at least that number of years. It is probable that when the groves on this creek started to grow there was a more abundant rainfall than characterized the country afterwards, until quite recently. This is also indicated by the largeness of the old creek-bed, which in its lower course now contains no water except during flood-time.

Water, however, even now, is abundant towards the upper end of the valley. Nine miles from the mouth I found a large number of magnificent springs and a considerable stream. Here the beavers had constructed many dams that had formed lakelets, some of which were partially filled with peat, attesting the great length of time during which this condition of things must have existed. The water, which is here so abundant, sinks into the creek-bed farther down. Along the valley, where the water still flows, and especially around the small lakes formed by the beaver dams, the vegetation was exceedingly rank, and yet the soil was not perceptibly different from the lower part of the valley. This is further evidence that all this region needs is a slightly increasing rainfall in order to make it one of the finest possible agricultural regions. In many places around and near these miniature lakes young timber is also starting.

Eight miles up the valley from the mouth of the creek, low down at the edge of a bluff, the Fort Pierre cretaceous shales were exposed. They contained a large quantity of selenite in fine crystals. Two miles further up the valley long ledges of Pliocene rocks capped the sides, and in some places the tops of the bluffs. At a distance from their vertical exposure they resembled gigantic masonry. On a closer examination they were found to be made up in part of silicates of lime, and conglomerate of the pudding-stone variety. The pebbles were cemented together generally by silicates of lime. Some of these rocks were intensely hard, and some on exposure crumbled or gradually de-

composed, thus forming, when the cement holding the pebbles together was washed away, gravel beds. There would, however, be little difficulty in obtaining large quantities of stone here, suitable at least for foundation purposes. From this point toward the southwest, the ledges of Pliocene rocks increase.

The uplands that bound the valley of Big Timber Creek, are mostly gently rolling, with some limited areas of rough land. The soil is composed of loess, fine drift material, and occasionally sandy tracts. These latter partake very largely of the character of the sandy lands near and at the Forks of the Republican, an analysis of which was given on a previous page. Very little territory here will turn out to be waste land, as the loess itself is so abundant that it will eventually support a dense population; and even if the sandy tracts are relegated to other purposes for awhile, they finally will be utilized, because, as has been shown, they also possess the elements of fertility in a high degree. The heavy matting of grasses and other vegetable matter, wherever moisture is supplied, is sufficient evidence of the abundance of mineral fertilizers in the soil.

Several smaller streams unite at different places with Big Timber Creek, multiplying the conditions of the main stream. At the first large exposure of the Pliocene rocks, nine miles from the mouth, it was difficult to tell which was the main stream, and which the tributary. The one flowing from the southwest seemed to have the least water, but its bottom was wide and beautiful.

The smaller streams which, coming from various directions, afford beautiful valleys and groves and valuable mill sites, will be described in the section of this work devoted to counties.

It is quite important to fix in the mind the precise order, or the name and location of the larger streams of the upper Republican. They have never been correctly located upon any map, and probably there are not a dozen men who can intelligently locate or describe them : Beginning with the Driftwood, flowing into the Republican from the south side, nine miles east of

Culbertson, and extending southwest through Hitchcock, Neb., and Rawlins county, Kansas. The next stream in order, following the main river into Dundy county, is the South Fork of the Republican, which diverges near range 38, and has a course southwest, terminating near Cedar Point, in Colorado, about 200 miles distant. Its principal tributary from the south is Big Timber Creek, already described. The North Fork of the Republican meets the South Fork at or near range 38, four miles north of the Kansas line, and forty-eight miles west of Culbertson. The Arickare, sometimes called Middle Fork, flows into the North Fork six miles East of Colorado line, and bears also towards the southwest in the direction of Denver. The North Fork bears almost due west from its junction with the South Fork, but is, in reality, one of the smaller tributaries. It is characterized by the usual variety of groves and springs. Frenchman's Fork, called sometimes White Man's Fork, already noticed, is next in order. The Blackwood empties into the Republican two and a half miles below Culbertson. It is densely wooded towards its mouth, with large groves of assorted timber, which, viewed from a distance, are very suggestive of the name it bears ; its course is from the northwest, forty to fifty miles at first through high rolling prairie, but in its upper sourees makes its way through deep loess canons filled with cedar groves. It is on this stream, several years ago, that a few pioneers began the "frontier farms," as they have since been called. They were duly cautioned against trying to farm in a region that could never raise grain of any kind, but several years of harvests have settled the important point in the controversy. Next comes Red Willow and Medicine Creeks, the most important tributaries from the north. They will be noticed in the more particular descriptions of counties. (See Furnas and Red Willow counties.) Draining a large basin already greatly depressed below the surrounding country, it is obvious that the Republican River must carry away a large supply of water by underdrainage. This idea has held possession of the people since the first settle-

ment of the country. This extra contribution of waters, as would naturally be supposed, comes from the north side. Hence has arisen the general impression that the great body of water in the sands beneath the Platte River reaches the Republican by the common process of filtering, or seeping. As evidence numerous facts are cited :

Many small streams from the north disappear in the sands when near the Republican.

Prof. Aughey has counted hundreds of springs giving their supplies to the Republican River below the water line, in addition to the multitude that are visible on the surface. The Republican constantly increases in volume as it flows eastward, independently of the tributaries, while the Platte constantly decreases in the same direction. The scarcely diminished flow of the Republican during the dry season of the year, and the steady and continuous flow of the Big Blue and its tributaries, which take their rise near to, but below the level of the Platte, tend strongly to confirm this theory. From these facts it is evident that the volume of water in the Republican and Big Blue Rivers is not directly but in a secondary manner dependent upon the constant and undiminished supply of the waters of the North and South Platte, which are supplied by the annual melting of snow and ice in the Rocky Mountains. It is easy to understand, also, that the extensive diversion of the waters of the Upper Platte, in Colorado, into many side channels, for stock and other purposes, would sensibly cause the flow of waters to diminish, not only in the Lower Platte, but would so reduce the amount of water in the Big Blue and Republican Rivers as to lead to grave legal complications between the two States.

It does not fall within the proper limits of this volume, intended to be merely descriptive of general phenomena, to give, in detail, the interesting theories that relate to glacier origin and action, or to the more complicated origin of the great loess formation, which occupies an area so large. But no one can avoid

the conclusion that all the territory occupied by the loess has been shaped into every variety of topographical forms, in the same manner as the purely drift regions surrounding it; and this implies that the loess is not merely a veneering of the previously shaped surface, but has itself been subject to the same glacial action.

The drainage system of this extensive region is so perfect that not an acre in a thousand is unfit for cultivation from excess of water. Crossing the prairie in any direction, we find that the lowlands, growing rank grasses and reeds, which generally indicate marshes, are nearly as firm as the uplands and ridges.

It is a wonderful system which thus provides for the drainage of every acre of land without loss. The solving of this problem indicates the highest wisdom. Our preachers may here find new views of the Divine Goodness quite as practical as those sublimer views which often beguile our moral teachers of so much valuable time. This promblem has been perfectly solved for the portion of Kansas and Nebraska under consideration. In performing this stupendous miracle there could be only one result, viz.: a system of rolling prairies. But lest we should seem to give undue importance to so common a fact, we ask any observer to notice that every acre of land has its own angle of inclination, giving in the aggregate millions of topographical lines, all diverse, and all so related as not in any way to hinder the escape of water falling in rains.

CHAPTER II.

GENERAL TOPOGRAPHY.

Comparative Altitudes, or Elevations of the Republican, Platte, and Niobrara River Valleys—Railway Elevations—Measures of Inclinations per Mile—Border Altitudes of Nebraska and Kansas—The Causes of our Present Topography—The Glacial Agency—Views of Geike and Agassiz—Nebraska Valleys—Modern Glacial Action—Perfect Drainage.

A STUDY of the comparative altitudes of the Republican Valley with other river valleys will afford a practical view of its peculiar system of topography, and will also greatly aid in understanding its physical conditions or surroundings, such as drainage, climate, and products.

A comparison of altitudes of corresponding localities of the meridian on the Platte and Republican rivers gives the following:

REPUBLICAN VALLEY.	*Feet.*	PLATTE VALLEY.	*Feet.*
Red Cloud	1,676	Grand Island	1,887
Hastings Divide, 1,940 Feet.			
Riverton	1,770	Wood River	2,011
Bloomington	1,930	Kearney	2,163
Republican City	1,986	Stevenson	2,236
Alma	2,018	Elm Creek	2,278
Orleans	2,150	Plum Creek	2,406
Arapahoe	2,250	Willow Island	2,547
Indianola	2,600	North Platte	2,825
Culbertson	2,760	O'Fallon's	3,012

A reference to the elevations will enable the reader to keep in mind the amount of general depression, which is one of the peculiar features of the Republican Valley, upon which depends its wonderful supply of water, which will be described more in detail in a future chapter.

Other lines and ranges of elevation are added, in order to furnish a still larger conception of the great feature—the lay of the land of the great central area—to describe which is the chief purpose of the work we have in hand.

ELEVATIONS NEAR THE SOUTH LINE OF THE STATE.

Falls City	**904**
Beatrice	**1,278**
Fairbury	**1,324**
Salem	**917**
Humboldt	**987**
Table Rock	**1,036**
Tecumseh	**1,120**
Sterling	**1,193**
Summit	**1,375**
Lincoln	**1,164**
Belvidere	**1,509**
Red Cloud	**1,679**
Bloomington	**1,930**
Orleans	**2,150**
Arapahoe	**2,250**
Indianola	**2,600**
Culbertson	**2,760**
State Line	**3,600**
Head of the Republican in Colorado	**4,050**

ELEVATIONS IN NEBRASKA, ALONG THE LINE OF THE UNION PACIFIC RAILWAY.

Omaha, Union Pacific R. R. Depot	**1,056**
Papillion	**1,009**
Elkhorn	**1,187**
Fremont	**1,220**
Schuyler	**1,372**
Columbus	**1,469**
Clarks	**1,647**
Lone Tree	**1,723**
Grand Island	**1,887**
Wood River	**2,011**
Gibbon	**2,088**
Kearney	**2,148**
Elm Creek	**2,278**

Plum Creek	2,406
Willow Island	2,547
Bradley	2,678
North Platte	2,825
O'Fallon's	3,012
Alkali	3,074
Ogalalla	3,225
Brule	3,301
Julesburg	3,535
Lodge Pole	3,835
Sidney	4,108
Antelope	4,747
Pine Bluffs	5,061

ELEVATIONS ALONG THE NORTH LINE OF THE STATE.

Niobrara	1,240
Mouth of Keya Paha	1,960
Mouth of Snake River	2,690
Camp Sheridan, Old Spotted Tail Agency	3,490
Camp Robinson	3,764
State Line on Cottonwood Creek	3,781
Indian Creek, northwest corner of State	4,018
Scott's Bluffs, thirty miles north of Pine Bluffs	6,051
Clark's Bridge, north of Sidney	3,707
Niobrara River, southeast of Fort Robinson	4,118
White Man's Fork on State Line, south of U. P. R. R.	3,188

From the preceding data, it is estimated that the eastern half of the State along the line of the Union Pacific Railway, has an average elevation of 1,700 feet; the western half 3,525 feet. The average elevation of the whole line would be 2,612 feet.

Along the south line of the State, the elevation of the eastern half averages 1,200 feet; the western half 2,672 feet.

Along the north line of the State, the data given make the eastern half, beginning at Ponca, 1,353 feet above the sea level; the western half averages about the same as that of the line of the Union Pacific Railway. It is proportionately greater along its middle, and less along its western portion. This would give an elevation of 2,312 feet for the whole State. This is a much smaller elevation than is usually given for the State, but it is the

Plate 1.—REPUBLICAN VALLEY, MOUTH OF ELM CREEK, NEAR RED CLOUD, NEB.

more accurate, because based on elevations along the north and south line, as well as through the centre of the State from east to west. Estimates, heretofore made, place the mean elevations at 2,550 feet.

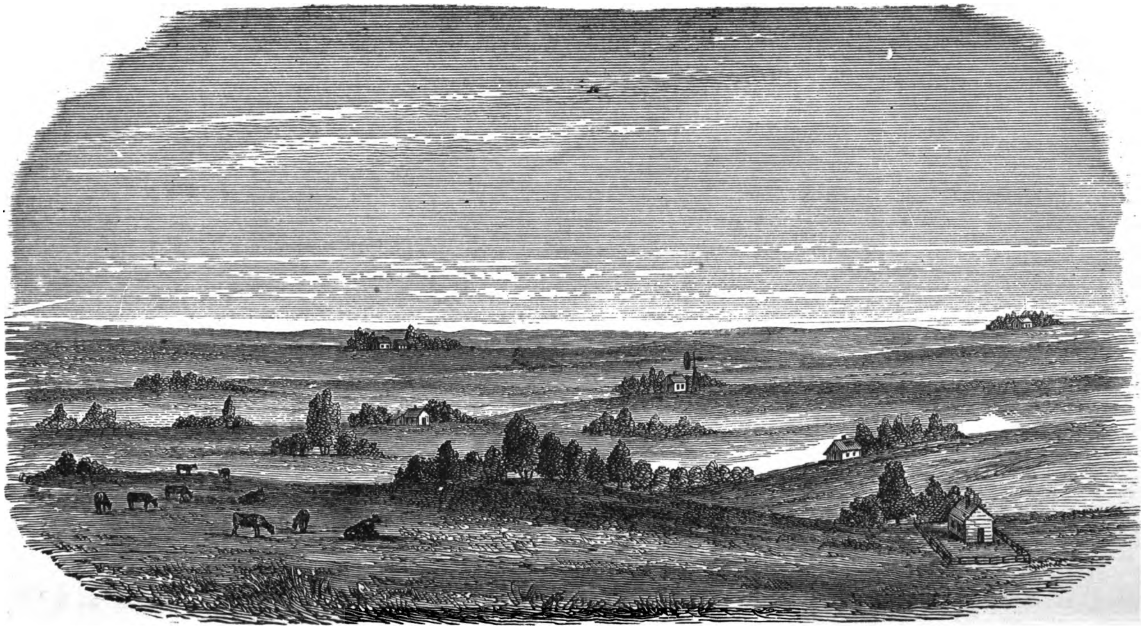
"For the first one hundred miles west from Omaha, the ascent is at the rate of five and a half feet to the mile; the second hundred miles increases the ascent to seven feet; the third hundred, seven and a half feet, and the fourth hundred to ten and a half feet to the mile. The ascent on the last fifty miles on the west end of the State, is eighteen feet to the mile. While these figures are not exact, they are close approximations to the truth. The calculation has been made for the line of the Union Pacific Railway; but the south line of the State differs very little from this. A similar gradual ascent characterizes the northern line of the State. It will be observed that the second and third hundred miles have almost the same gradual ascent. After this, the ascent increases quite rapidly until it reaches eighteen feet to the mile. The increase of elevation, going north and west on the eastern boundary of the State along the Missouri, is much less. Taking the mouth of the Nemaha as our starting point, whose elevation is 878 feet, and comparing it with the elevation of the Missouri bottom, at Omaha, which is 1,002 feet, we have a difference of 124 feet, or a rise of one and a fourth feet to the mile. The fall between Omaha and Dakota City is even less than this.

"In Western Nebraska, the difference in elevation between the south line of the State and the Union Pacific Railway, approximates to 352 feet. On the west line of the State, the ascent continues going north, until, at Scott's Bluff, an elevation of 6,051 feet is reached. Although this is only approximately correct, as I took the observations with a barometer, yet there is little doubt that this is the highest point in the State. From here there is a gradual descending slope to the north line of the State, with some intervening inequalities and depressions in the valleys of the Niobrara, the White Earth, and Indian Creek.

From the Republican River on the west line of the State, to Big Springs, in the same meridian on the Union Pacific Railway, there is an ascent of 352 feet. From this latter place, there is a still further rise of 283 feet to the Niobrara River, or a total ascent along this line from south to north, of 635 feet, against a corresponding difference of less than 200 feet along the eastern border of the State. It will also be remembered, that the lowest part of the State is its southeast corner; and the highest part is a point north of the Union Pacific Railway, on Scott's Bluffs. Take the State, therefore, as a whole, and it will be seen that it slopes mainly toward the east; and in a minor degree toward the south. The only exception to this rule is the extreme western line of the State, where the Colorado notch has taken from Nebraska territory a section which legitimately should belong to her. Because of this shortening of our southwestern border, Pine Bluffs, the last station of the Union Pacific Railway in Nebraska, is near the south line of the State. From here, the ascent toward the north continues only for about thirty-six miles, to Scott's Bluffs, from which there is a gradual descent to Indian Creek, near the northwest corner of the State. But eastward from this point, the descent is generally south, and still more east. As would be expected from such relief-forms, the great majority of the tributaries of the main streams, except those of the Niobrara, flow toward the southeast.

Concerning the great number and variety of Nebraska valleys, Prof. Aughey further says:

"Nothing is more surprising to one who studies the relief-forms of the State, than the amazing number of valleys or bottom lands. Some writers have stated that there were several hundred. It would have been more correct to have reported several thousand. Take the region of the Republican as an example. On an average, a tributary valley comes into the main bottom from the north side every two miles. Now, as this river flows for two hundred miles through the State, it would give



VIEW ON FARMERS' CREEK, FRANKLIN CO., NEB.

Plate 2.

one hundred for this section alone. Counting, however, the streams that come in from the south side, and those flowing into its larger tributaries, this number should be multiplied by at least four; giving four hundred valleys, great and small, for this region alone. Now, add to these valleys those that are tributary to the Platte—the Blues, the Nemahas, the Elkhorns, the Logan, the Bows, the Missouri between its larger tributaries, the Niobrara and the Loups—and it will increase the number to thousands. It is true that many of them are narrow, ranging from one-fourth to a mile in width; but they are valleys with living or extinct stream-beds in the middle, or toward one side of them, and having all the physical features of the larger river bottoms. As already intimated, there are a few minor valleys among the smaller tributaries of the upper Elkhorns, Loups, Niobrara and Republican, in the stream-beds of which the water no longer flows; but, as will be shown further on, many of them are regaining, and all of them will in time, contain their former supply of water. Thus can be seen why, over a large part of Nebraska, the settler can have his choice between bottom and upland. The great body of these bottom lands, though composed of the richest mould and modified alluvium and loess materials, are pertectly dry. It is true, that swamps are occasionally met with, but they occur at long intervals, and are an exception."

A general view of the topography of the Republican Valley and its great system of confluent valleys, suggests the unity of the vast drainage system for Southern Nebraska, Northern Kansas, and Eastern Colorado. The Republican, Solomon, Saline, Smoky Hill, Kaw, and Big Blue are the leading rivers of one extensive inland basin. It would be most proper, following the common custom, to give the name of the most important of these rivers—the Republican—to the entire system.

But the mere accident of a misapplied name will not deter the acute observer from noting the grand divisions of this great hydrographical basin.

The lowest lines of drainage, or in other words, the channels of the largest rivers were, doubtless, determined during the latest submergence. Where now runs the current of the Mississippi River with its great tributary, was formerly the line of deepest water in the ocean that last covered the continent.

The ocean bed, reversing the terms, on becoming a vast continental area, retains the general topography impressed upon it by previous ages of oceanic distribution and deposit, modified by the direction and force of currents. In this manner the grand features were, doubtless, determined, leaving to terrestrial agencies in subsequent ages, the supplementary work of shaping and sculpturing the common surface of the country as we now find it.

Foremost among their forces, must be reckoned the glaciers during the great ice age. Of its origin, duration, and results, the reader is referred to the works of Agassiz, Tyndall, and Geike. But when it had passed away, its workwas manifested in every valley, canyon, ravine, rounded slope, draw, and divide that constitute our present diversified surface.

The terms of the glacier problem are so stupendous that they require not only years of observation in order to become familiar with them, but also much experience and exercise of judgment in estimating the action of forces by which their enormous results are effected: the causes of ice accumulation; its onward motion and regelation; its duration and final disappearance; its constant melting into water beneath, and its rapid flow with mingled and dissolved material—here assorted and stratified and there left in promiscuous heaps—in one place drift-clay, and in another sifted sand; sometimes rich with fine gold, ground and distributed by the same power under the weird manipulation of water. To analyze these phenomena and combine them with many others into one climatic era or age of glaciers, renders it the highest problem in the physical history of the earth.

We only have to conceive a blanket of ice, covering the north-

ern portion of the continent and extending as far south as 30° N., and increasing in thickness northward from 1,000 to 2,000 feet over the region of the 40th parallel.

The great mass rests upon the earth, which is still warm from interior heat. With every cubic foot weighing over 60 pounds, the pressure is prodigious. Melting away beneath by the uniform warmth, and escaping to lower levels, the waters have their course in cutting, grooving, rounding, and shaping, under this superincumbent grinding pressure, until, when the glacier age has closed, there results a topography such as in the main we see it now. The Great Valley, with its larger valleys, was predetermined by previous inclines; but the ten thousand smaller valleys, canons, vales, etc., etc., were the accidental exigencies of escaping waters under enormous pressure.

It will greatly aid our estimate of the glacial process to read a descriptive page from Agassiz, who first presented the glacier theory as the cause of our topography.

Of the more ancient, or drift glaciers, which have given us our general topography, Agassiz remarks:

"The loose materials which produced, in their onward movement under the pressure of ice, such polishing and grooving, consisted of various sized boulders, pebbles, and gravels, down to the most minute sand and loamy powder. Accumulations of such materials are found everywhere upon the smooth surfaces, and in their arrangements they present everywhere the most striking contrast, when compared with deposits accumulated under the agency of water. Indeed, we nowhere find this glacial drift regularly stratified, being everywhere irregular accumulations of loose materials, scattered at random without selection, the coarsest and most minute particles being piled up irregularly in large or smaller heaps, the greatest boulders standing sometimes uppermost, or in the centre, or in any position among the smaller pebbles and impalpable powder.

With respect to the irregular accumulations of drift-materials in the north, I may add, that there is not only no indication of

stratification among them, such unquestionably as water would have left, but that the very nature rf these materials shows plainly that they are of terrestrial origin; for the mud which sticks between them adheres to all the little roughnesses of the pebbles; fills them out, and has the peculiar adhesive character of the mud ground under the glaciers, and differing entirely, in that respect, from the grounds, and pebbles, and sands, washed by water currents, which leave each pebble clean, and never form adhering masses, unless penetrated by an infiltration of limestone."

Glaciers, says Geike, "like rivers, are of all sizes. Many have a depth of several hundred feet; and, save in the polar regions, are probably not less than 3000, or even 5000 feet in thickness. It may be easily conceived, that the pressure of such enormous masses of ice must have a prodigious effect. When a glacier advances beyond its usual limits, everything goes down before it. Loose soils and debris are pushed forward, and the strongest and thickest trees are overborne, just as if they were so many straws. But striking as these examples of the irresistible force may be, the destructive, and overwhelming power of ice in motion, becomes still more noteworthy, when the rocks over which the glacier passes are examined. This may be done in summer time, when the glaciers shrink from the sides of their valleys. Creeping in below the ice, which is often possible to do for some little distances, we find the rocks finely smoothed and polished, and showing straight ruts, that run parallel to the course followed by the glacier. If we pick out some of the stones that are sure to be scattered about below the ice, we shall find thar many are smoothed, polished, and striated in the same manner as the surface of the rock itself. All this is the work of the glacier."

But we have here no need either to cross the sea and study Alpine glaciers with Geike and Agassiz, or to grope our way over the confused drift of a geological era. The same work of shaping, and sculpturing the surface; in short, topography-

making, which was here completed long ago, is now going on in Alaska, unequaled in force and grandeur in modern or ancient times, in any part of the earth.

Of these a recent explorer gives the following brief, but graphic description of a living, moving glacier, in all its sublimity and grandeur:

"Arriving opposite the mouth of the fiord we steered straight inland, between wooded shores surpassingly beautiful, and the grand glacier came in sight, lying at home in its massive granite valley, glowing in the early sunshine, and extending a noble invitation to come and see. After we were fairly between the two majestic mountain rocks that guard the gate of the fiord, the view that was unfolded fixed every eye in wondering admiration. No written words, however builded together, can convey anything like an adequate conception of its sublime grandeur—the noble simplicity and the fineness of the sculpture of the walls; their magnificent proportions, their cascade, garden and forest adornments; the placid water between them; the great white ice-wall stretching across in the middle, and the snow-laden mountain peaks beyond. Still more impotent are words in telling the peculiar awe one experiences in entering these virgin mansions of the icy North, notwithstanding it is only the perfectly natural effect of simple and appreciable manifestations of the presence of God.

"Standing in the gate-way of this glorious temple, and regarding it only as a picture, its outlines may be easily traced. There is the water foreground of a pale, milky-blue color, from the suspended rock-mud issuing from beneath the grinding glacier—one smooth sheet sweeping back five or six miles like one of the lower reaches of a great river. At the head, the water is bounded by a barrier-wall of bluish-white ice, from 500 to 600 feet high, a few mountain-tops crowned with snow appearing beyond it. On either hand stretches a series of majestic granite rocks, from 3,000 to 4,000 feet high, in some places bare, in some forested and well patched with yellow-green chapparal and flow-

ery gardens, especially about half-way up from top to bottom, and the whole built together in a general, varied way into walls, like those of Yosemite Valley, extending far beyond the ice-barrier, one immense brow appearing beyond the other, while their bases are buried in the glacier. This is, in fact, a Yosemite Valley in process of formation, the modeling and sculpture of the walls nearly completed and well planted, but no groves as yet, or gardens, or meadows on the raw and unfinished bottom. It is as if the explorer, in entering the Merced Yosemite, should find the walls nearly in their present condition, trees and flowers in the warm nooks and along the sunny portions of the moraine-covered brows, but the bottom of the valley still covered with water and beds of gravel and mud, and the grand trunk glacier that formed it slowly melting and receding, but still filling the upper half, its jagged snout extending all the way across from the Three Brothers to a point below the Sentinel.

"Sailing directly up to the sunken brow of the terminal moraine, we then seemed to be separated from the glacier only by a low, tide-leveled strip of detritus, a hundred yards or so in width; but on so grand a scale are all the magnitudes of the main features of the valley, that we afterwards found it to be a mile or more.

"The captain ordered the Indians to get out the canoe and take as many of us ashore as wished to go, and accompany us to the glacier, also, in case we should desire them to do so. Only three of the company, in the first place, availed themselves of this rare opportunity of meeting a grand glacier in the flesh—the missionary, one of the doctors and myself. Paddling to the nearest and dryest-looking portion of the moraine, we stepped ashore, but gladly wallowed back into the canoe; for the gray mineral mud, a paste made from fine mountain meal, and kept unstable by the tides, at once took us in, swallowing us feet foremost with becoming glacial deliberation. Our next attempt, made nearer the middle of the valley, was successful, and we soon found ourselves on good gravel ground. I made haste in

a direct line for the huge ice-wall, which seemed to recede as we approached. The only difficulty we met was a network of icy streams, at the largest of which we halted, not willing to get wet in fording. The Indian we had elected to go along with us promptly carried us over the difficulty on his back. When my turn came I told him I would ford, but he bowed his shoulders in so ludicrously pensive a manner I thought I would try the mount, the only one of the kind I had enjoyed since game-day boyhood. Away staggered my perpendicular mule over the boulders and cobble-stones into the brawling torrent. The sensations experienced were most novel and most unstable, but, in spite of a dozen top-heavy predictions to the contrary, we crossed without a fall.

"At length, after being ferried in this way over several more of these outrushing glacial streams, we reached the glorious crystal wall, along which we passed, admiring the noble architecture, the play of light in the rifts and angles, and the structure of the ice as displayed in the less fractured sections, etc., finding fresh beauty and facts for study at every step. The doctor soon left us to return to the boat, taking the Indian with him for portage purposes, while the missionary and I, by dint of patient zigzagging and doubling among the crevices, and a vigorous use of our ax in cutting steps on the slopes and cliffs, made our way up over the snow and back a mile or so over the cascading brow to a height of about seven hundred feet above the base of the wall. Here we obtained a glorious view.

"The whole front and brow of this majestic glacier is gashed and sculptured into a maze of yawning chasms and crevasses, and a bewildering variety of strange architectural forms, appalling to the strongest nerves, but novel and beautiful beyond measure—clusters of glittering lance-tipped spires, gables and obelisks, bold outstanding bastions and plain mural cliffs, adorned along the top with fretted cornice and battlement, while every gorge and crevasse, chasm and hollow, was filled with light, shimmering and pulsing in pale blue tones of

ineffable tenderness and loveliness. The day was warm, and back on the broad waving bosom of the glazier, water-streams were outspread in a complicated net-work, each in its own frictionless channel cut down through the porous, decaying ice of the surface into the quick and living blue, and flowing with a grace of motion and a ring and gurgle and flashing of light to be found only on the crystal hills and dales of a glacier.

"Along the sides we could see the mighty flood grinding against the granite with tremendous pressure, rounding the out-swelling bosses, deepening and smoothing the retreating hollows, and shaping every portion of the mountain walls into the forms they were meant to have when, in the fullness of appointed time, the ice-tool should be lifted and set aside by the sun. Every feature glowed with intention, reflecting the earth-plans of God. Back two or three miles from the front the current is now probably about one thousand two hundred feet deep; but when we examine the walls, the grooved and rounded features, so surely glacial, show that in the earlier days of the ice age they were all overswept, this glacier having flowed from three thousand to four thousand feet above its present level.

"Standing here, with facts so fresh and telling, and held up so vividly before us, every seeing observer, not to say geologist, must really apprehend the earth-sculpturing, landscape-making action of flowing ice. And here, too, one easily learns that the world, though made, is yet being made; that this is still the morning of creation; that mountains, long conceived, are now being born, brought to light by the glaciers, channels traced for rivers, basins hollowed for lakes; that moraine soil is being ground and out-spread for coming plants, coarse boulders and gravel for the forests, finer meal for grasses and flowers, while the finest water-bolted portion of the grist, seen hastening far out to sea, is being stored away in the darkness, and builded, particle on particle, cementing and crystallizing, to make the mountains, and valleys, and plains of other landscapes, which, like fluent, pulsing water, rise and fall, and pass on through the ages in endless rhythm and beauty.

CHAPTER III.

The Soil of Nebraska and Areas Adjacent—Description of the Great Loess Deposit of North America—Its Probable Origin—Theories: 1st, Sub-Aerial; 2d, Sub-Aqueous; 3d, Chemical Precipitation—Its Capacity to Retain Moisture—Experiments.

PURSUING the natural order in our description, we will consider next the peculiar soil of Nebraska. This will inevitably lead us into a somewhat prolonged discussion of the Great Loess formation—its probable origin and extent; its peculiarities and proper mode of treatment, based upon numerous experiments, and also upon its constitution or chemical constituents. From surveys as yet incomplete, the loess formation embraces nearly the entire area of Nebraska, a large portion of Northern and Northeastern Kansas, Western and Northwestern Iowa, Southern and Southwestern Dakota, and reaches into Colorado before the great bands of drift and gravel near the meridian. Tracing its limits we find its area is circular, but with an elongation toward the west and north.

It also extends southward, following the Missouri River throughout its entire course. It is also found in limited areas along the Missouri River; for instance, a considerable region around Memphis, Tennessee, and in smaller areas toward the Gulf of Mexico.

Its physical character is everywhere the same. It has a prevailing yellow color, with a neutral tint or shade. Its specific gravity is nearly the same as water. It is composed mechanically of exceedingly fine particles, mostly crystals of silica, potassa, magnesia, soda and lime. This minute crystalline structure disposes the loess formation in mass to assume a basaltic or columnar form, which is readily recognized wherever the loess is exposed along rivers, ravines, and railway cuts.

This prismatic or columnar structure enables it to stand or maintain itself in solid walls, unimpaired for years. Cellars, cisterns and wells, cut directly in or through this formation, have the same face or escarpment, and will not change or disintegrate if protected from storms of rain and sleet.

One may more readily understand this peculiarity by supposing that the crystals of soda, potassa, magnesia and silica, of which this soil is mainly composed, have arranged themselves by some polarity in the line of their longer axes, and not in a promiscuous manner; so that the clearage lines by which the columns or smooth wall surfaces seem to be outlined or pre-determined, readily extend along the continuous surfaces of these minute crystals. Says Professor Pumpelly, of Cambridge: "This remarkable formation covers several hundred thousand square miles in Northern China, and larger areas in the east of Asia. Its thickness varies in China from 10 to 2,000 feet, and to 150 to 200 feet in Europe and America.

Loess is a calcareous loam. It is easily crushed in the hand to an almost impalpable powder. Yet it will support itself in vertical cliffs 200 feet high.

It is wholly unstratified, and often, where erosion has cut into it, whether one foot or one hundred yards, the walls are absolutely vertical. When undermined the loess breaks off in immense vertical plates, leaving a perpendicular wall. This remarkable combination of softness, with great strength, is of inestimable value in a woodless country. In Asia thousands of villages are excavated in the most systematic manner at the base of cliffs of loess. Doors and windows pierced through the natural front wall, give light and air to suites of rooms within. These are the comfortable dwellings of many millions of Chinese farmers, and correspond to the ruder dug-outs of the western frontier.

In his very accurate and minute description Prof. Aughey* remarks: "This deposit, although not particularly rich in or-

*See sketches of the physical geography and geology of Nebraska.

ganic remains, is in some respects one of the most remarkable in the world. Its value for agricultural purposes is not exceeded anywhere. It prevails over at least three fourths of the surface of Nebraska. It ranges in thickness from five to one hundred and fifty feet. Some sections of it in Dakota county measure over two hundred feet. At North Platte, 300 miles west of Omaha, and on the south side of the river, some of the sections I measured ranged in thickness from one hundred and twenty-five to one hundred and fifty feet.

"South of Kearney, and for a great distance west, along the Union Pacific Railway as far as to the Republican, there is a great expanse of territory covered by a great thickness of this deposit. I measured many sections in wells over this region, and seldom found it less than forty, and often more than sixty feet in thickness. Along the Republican I traced the formation almost to the western line of the State, its thickness ranging from thirty to seventy feet. One peculiarity of this deposit is that it is generally almost perfectly homogeneous throughout, and of almost uniform color, however thick the deposit, or far apart the specimens have been taken. I have compared many specimens taken 300 miles apart, and from the top and bottom of the deposits, and no difference could be detected by the eye or by chemical analysis.

"Over 80 per cent. of this deposit is very finely comminuted silica. When washed in water, left standing and the water poured off, and the coarser materials have settled, the residum, after evaporation to dryness is almost entirely composed of fine silicious powder. So fine, indeed, are the particles of silica, that its true character can alone be detected by analysis or under a microscope. About ten per cent. is composed of the carbonates and phosphates of lime. These materials are so abundant in these deposits, that they spontaneously crystalize, or form concretions from the size of a shot to that of a walnut; and these are often hollow or contain some organic matter, or a fossil, around which the crystallization took place. This deposit also

contains small amounts of alkaline matter, iron, and alumnia. For the purpose of showing the homogeneous character and the chemical properties of the loess deposits, I have made five new analyses of this soil. No. 1 is from Douglas county, near Omaha; No. 2 from the bluffs near Kearney; No. 3 from the Lower Loup; No. 4 from Sutton, and No. 5 from the Republican Valley, near Orleans, in Harlan county.

	NO. 1.	NO. 2.	NO 3.	NO 4.	NO 5.
Insoluble (silicious) matter	81.28	81.32	81.35	81.30	81.32
Ferric oxide	3.86	3.87	3.83	3.85	3.86
Alumnia	.75	.75	.74	.73	.74
Lime, carbonate	6.06	6.06	6.03	6.05	6.09
Lime, phosphate	3.59	3.59	3.58	3.57	3.59
Magnesia	1.28	1.28	1.31	1.31	1.29
Potassa	.27	.29	.35	.34	.33
Soda	.15	.16	.14	.16	.16
Organic matter	1.97	1.06	1.05	1.06	1.06
Moisture	1.09	1.08	1.09	1.08	1.09
Loss in analysis	.59	.54	.53	.55	.47
Total	100.00	100.00	100.00	100.00	100.00

"After making the above analyses I received from Dr. Hayden his Final Report on the Geology of Nebraska. This report, on page 12, contains two analyses of the loess deposit from Hannibal Mo., made by Litton. According to these analyses, from one hundred parts there were—

	NO. 1.	NO. 2.
Silica	76.98	77.02
Alumina and peroxide of iron	11.54	12.10
Lime	3.87	3.25
Magnesia	1.68	1.63
Carbonic acid	Not determined	2.83
Water	2.01	2.43
Total	96.17	99.26

According to these analyses the loess contains more clay in Missouri than it does in Nebraska. The analyses that I made

of two specimens of loess from Richardson county also contained slightly more alumina than the above.

For the purpose of comparison, I here reproduce, from Hayden's report, Bischoff's analyses of the lacrustrine or loess of the Rhine:

	NO. OF ANALYSIS.				
	1.	2.	3.	4.	5.
Silicic acid	58.97	79.53	78.61	62.43	81.04
Alumina	9.97	13.45 }	15.26	7.51	.75
Peroxide of iron	4.25	4.81 }		5.14	.67
Lime	0.02	0.02	....	....	......
Magnesia	0.04	0.06	0.09	0.21	0.27
Potash	0.11	1.05 }	3.31	1.75	2.27
Soda	0.84	1.14 }			
Carbonate of lime	20.16	....	....	11.63	......
Carbonate of magnesia	4.21	....	....	3.02	......
Loss by ignition	1.37	....	1.89	2.31	......

"It will be seen from the above analysis of Bischoff that Nos. 3 and 5, in the quantity of silica and other elements that are present, come very near the loess of Nebraska. The principal difference is the larger quantity of alumina present in the samples analyzed by Bischoff. Chemically, the deposits of the Rhine Valley, as Hayden remarks, are not essentially different from those of the loess soils along the Missouri.

"As would be expected, from the elements which chemical analysis shows to be present in these deposits, it forms one of the best soils in the world. In fact, it can never be exhausted until every hill and valley of which it is composed is entirely worn away. Its drainage, which is the best possible, is owing to the remarkably finely comminuted silica of which the bulk of the deposit consists. Where the ground is cultivated the most copious rains percolate through the soil, which, in its lowest depths, retains it like a huge sponge. Even the unbroken prairie absorbs much of the heavy rains that fall. When droughts come the moisture comes up from below by capillary attraction. And when it is considered that the depth to the

solid rock ranges generally from five to two hundred feet, it is seen how readily the needs of vegetation are supplied in the dryest seasons. This is the main reason why over all the region where these deposits prevail the natural vegetation and the well-cultivated crops are rarely dried out or drowned out. I have frequently observed a few showers to fall in April, and then little more rain until June, when, as will be considered further on, there is generally a rainy season of from three to eight weeks' continuance. After these June rains little more would fall till autumn; and yet, if there was a deep and thorough cultivation, the crops of corn, cereals and grass would be most abundant. This condition represents the dry seasons. On the other hand, the extremely wet seasons only damage the crops over the low bottoms, subject to overflow. Owing to the silicious nature of the soils they never bake when plowed in a wet condition, and a day after heavy rains the plow can again be successfully and safely used.

"The physical properties of the loess deposits are also remarkable. In the interior, away from the Missouri, hundreds of miles of these loess deposits are almost level, or gently rolling. Not unfrequently a region will be reached where, for a few miles, the country is bluffy or hilly, and then as much almost entirely level, with intermediate forms. The bluffs that border the flood-plains of the Missouri, the Lower Platte, and some other streams, are sometimes exceedingly precipitous, and sometimes gently rounded off. They often assume fantastic forms, as if carved by some curious generation of the past. But now they retain their forms so unchanged from year to year, affected by neither rain nor frost, that they must have been molded into their present outlines under circumstances of climate and level very different from that which now prevails.

"For all purposes of architecture this soil, even for the most massive structure, is perfectly secure. I have never known a foundation of a large brick or stone building, if commenced below the winter frost line, to give way. Even when the first

layers of brick and stone are laid on top of the ground there is seldom such unevenness of settling as to produce fractures in the walls. On no other deposits, except the solid rock, are there such excellent roads. From twelve to twenty-four hours after the heaviest rains the roads are perfectly dry, and often appear, after being traveled a few days, like a vast floor formed from cement, and by the highest art of man. The drawback to this picture is that sometimes during a drought the air along the highways on windy days is filled with dust. And yet the soil is very easily worked, yielding readily to the spade or plow. Excavation is remarkably easy, and no pick or mattock is thought of for such purposes. It might be expected that such a soil readily yielded to atmospheric influences, but such is not the case. Wells in this deposit are frequently walled up only to a point above the water line; and on the remainder the spade-marks will be visible for years. Indeed, the traveler over Nebraska will often be surprised to see spade-marks and carved-out names and dates years after they were first made, where ordinary soils would soon have fallen away into a gentle slope. This peculiarity of the soil has often been a God-send to poor emigrants. Such often cut out of the hillsides a shelter for themselves and their stock.

"These peculiarities of the loess deposits are chiefly owing to the fact that the carbonate of lime has entered into slight chemical combination with the finely comminuted silica. There is always more or less carbonate acid in the atmosphere which is brought down by the rains, and this dissolves the carbonate of lime, which then readily unites with silica, but only to a slight extent, and not enough to destroy its porosity. Though much of the silica is microscopically minute, and is water-worn or rounded, it still enters into this slight union with the carbonate of lime. Had there been more lime and iron in this deposit, and had it been subjected to a greater and longer pressure from superincumbent waters, instead of a slightly chemically compacted soil, it would have resulted in a sandstone formation,

incapable of cultivation. There is not enough of clayey matter present to prevent the water from percolating through it as perfectly as through sand, though a great deal more slowly. This same peculiarity causes ponds and stagnant water to be rare within the limits of this deposit. Where they do exist in slight depressions on the level plain, it is found that an exceptionally large quantity of clayey matter has been accumulated in the soil on the bottom.

In these loess deposits are found the explanation of the ease with which nature produces the wild fruits in Nebraska. So dense are the thickets of wild grapes and plums along some of the bottoms and bluffs of the larger streams that it is difficult to pentrate them. Over twenty varieties of wild plums have been observed, all of them having originated either from *Prunus Americana*, *P. chickasa*, or *P. pumillo*. Only two species of grapes are clearly outlined, namely, *Vitis æstivalis* and *V. cardifolia*, but these have such interminable variations that the botanist becomes discouraged in attempting to draw the lines between them, and to define the range and limit of the varieties. The same remark could be made of the strawberries. Raspberries and blackberries abound in many parts of the State. The buffalo-berry (*Shepherdia Canadensis*) is common on many of the Missouri and Republican river bottoms. Many other wild fruits abound, and grow with wonderful luxuriance wherever timber protects them and prairie fires are repressed. As would be expected, these deposits are also a paradise for the cultivated fruits of the temperate zones. They luxuriate in a soil like this, which has perfect natural drainage, and is composed of such materials. No other region, except the valleys of the Nile and of the Rhine can, in these respects, compare with the loess deposits of Nebraska. The loess of the Rhine supplies Europe with some of its finest wines and grapes. The success that has already attended the cultivation of the grape in Southeastern Nebraska, at least, demonstrates that the State may likewise become remarkable in this respect.

For the cultivation of the apple, its superiority is demonstrated. Nebraska, although so young in years, has taken the premium over all the other States in the pomological fairs at Richmond and Boston. Of course there are obstacles here in the way of the pomologist as well as in other favored regions. But what is claimed is, that the soil, as analysis and experience prove, is eminently adapted to grape, and especially to apple-tree culture.

Scenery of the Loess Deposits.

"It has been remarked 'that no sharp lines of demarcation separate the kinds of scenery that produce the emotions of the grand and the beautiful.' This is eminently true of some of the scenery produced by the loess formations. Occasionally an elevation is encountered from whose summit there are such magnificent views of river, bottom, forest, and winding bluffs as to produce all the emotions of the sublime. If it happens to be Indian summer, the tints of the wood vie with the hazy splendor of the sky to give to the far outstretched landscape more than an oriental splendor. I have looked with amazement at some of the wonderful canyons of the Rocky Mountains, but nothing there more completely filled me and satisfied the craving for the grand in nature than these views.

"The alternations of lofty bluff and bottom, woodland and prairie, give a picture worthy the pencil of the most gifted artist, and of all who love the grand and picturesque in nature. It is true that such scenes are rare, but then there are many landscapes which, if not grand, are still of wonderful beauty. This is the case along most of the bluffs of the principal rivers. In Northern Nebraska these bluffs often reach two hundred or more feet in height, and this perhaps gives this portion of the State the most varied scenery. At some points these bluffs are rounded off and melt beyond into a gently-rolling plain. But they constantly vary, and following them you come now into a beautiful cove, now to a curious headland, then to terraces, and, however far you travel, you in vain look for a picture like the

one just passed. Numerous rounded tips, with strangely precipitous sides, are seen in every hour's travel, and these, as they form bold curves, stretch away into the distance and form images of the most impressive beauty. Indeed, the bluffs of the loess deposits are unique, and Ruskin cannot exhaust the subject of the beautiful until he sees and studies the hills of Nebraska."

It would be most interesting to present in detail the two theories of the origin of these remarkable deposits. The reader is referred to Prof. Aughey's recent work on the Physical Geography and Geology of Nebraska for a full and complete discussion of this subject. Only the outline of these theories can be properly presented within our limits. Prof. Pumpelly, who has written much on the loess deposits of the Chinese Empire, thus describes the sub-aerial theory of Richtofen, which he finally adopts, having formerly regarded the aqueous theory as most tenable.

RICHTOFENS'S THEORY:

Whenever, from any cause, the winds blowing towards an interior portion of a continent are drained of their moisture on the way, as by the elevation in their path of lofty condensing mountains, the region thus deprived of its rain-bringing clouds soon has its evaporation in excess of its rainfall. Its streams dry up, and soluble and insoluble products of disintegration are no longer carried to the ocean. The region becomes what Richtofen calls a central area, in contrast to shore regions which are drained directly into the ocean. The destruction of the vegetation lays bare the surface, and the products of the disintegration are blown and sorted by the wind, and washed by the occasional rains from the hill down into the valleys. This material is very nutritive for the support of grasses. The dust left by the winds and the hill-wash are arrested by the grass, which they gradually bury while forming the soil for new growths. In this way portions of the country become buried in their own and their neighbors' debris. Great thicknesses thus gradually

accumulate, undergoing a transformation into loess by the rootlets and stems of the vegetation. Richtofen remarks that the grain regions of Northern China have been continuously cultivated for more than 4,000 years, and are self-fertilizing.

This he ascribes partly to the porosity of the material which caused it to absorb carbonic acid and ammonia in large amounts from the air, but more especially to the elevation of nutritive salts in the capillary tubes by diffusion, whenever a rain establishes a moist communication between the surface and the saline waters below the drainage level.

"Thus as climatic changes restore more or less moisture to the atmosphere of a loess district, we have in it the utmost fertility."

Prof. Aughey, who has in preparation a work on the loess deposits of North America, disposes of the theory of Richtofen, and traces this formation for its origin to aqueous agency.

He begins with the generally admitted fact, of a vast interior lake, or sea, on the authority of Prof. Newberry and others, extending over the present area of loess formation.

In Nebraska during this time icebergs again floated over the waters. The farther retreat of the glaciers and the elevation of Eastern Iowa reduced the area of this great lake. What had been a great interior sea of turbulent waters, had now become a system of placid lakes that extended from Nebraska and Western Iowa at intervals to the Gulf. The Missouri drained through them. The Missouri, and sometimes the Platte, have been among the muddiest streams in the world. If we go up the Missouri to its source, and carefully examine the character of the deposits through which it passes we cannot but be surprised at its character. These deposits being of Tertiary and Cretaceous ages, are exceedingly friable, and of easy disintegration. The Tertiary, and especially the Pliocene Tertiary, is largely silicious, and the Cretaceous is both silicious and calcareous. In fact, in many places the Missouri and its tributaries flow directly over and through the chalk-beds of the Cretaceous deposits. From these beds the loess deposits

no doubt received their per cent. of the phosphates and carbonates of lime. Flowing through such deposits for more than a thousand miles, the Missouri and its tributaries have been gathering for vast ages that peculiar mud which filled up their ancient lakes, which distinguishes them even yet from most other streams. Being anciently, as now, very rapid streams, as soon as they emptied themselves into these great lakes, and their waters became quiet, the sediment held suspended was dropped to the bottom. While this process was going on in the earlier portion of this age, the last of the glaciers had probably not retreated farther than first a little beyond the boundary of the loess lake, and then gradually to the headwaters of the Platte, the Missouri and the Yellowstone. The tremendous force of these mighty rivers was, for a while at least, aided by the erosive action of ice, and therefore must have been vastly more rapid at times than anything of the kind with which we are now acquainted. The following analysis of Missouri river sediment taken at high stage will show, by comparison with the analyses of the loess deposits, what a remarkable resemblance there is even yet between the two subtances.

In one hundred parts of Missouri River sediment, there are of—

Insoluble (silicious) matter	82.01
Ferric oxide	3.10
Alumina	1.70
Lime, carbonate	6.50
Lime, phosphate	3.00
Magnesia, carbonate	1.10
Potassa	.50
Soda	.22
Organic matter	1.20
Loss in analysis	.67
Total	100.00

Two analyses which I made, the one from the sediment at high water and the other at low water, differ somewhat from this, but in essential particulars are the same. This identity of

chemical combination also points to the remarkable sameness of conditions that have existed for long periods in the Upper Missouri and Yellowstone regions.

After these great lakes were filled with sediment (Missouri mud), they existed for a longer or shorter time, as already remarked, as marshes or bogs. Isolated portions would first become dry land, and as soon as they appeared above the water they were no doubt covered with vegetation, which, decaying from year to year, and uniting under water or at the water's edge with the deposits at the bottom, formed that black soil so characteristic of Nebraska prairies. For it is well known that when vegetable matter decays in water or a wet situation its carbon is retained. In dry situations it passes into the atmosphere as carbonic-acid gas. After the first low islands appeared in this old lake, they gradually increased from year to year in size and numbers.

The ponds and sloughs, some of which could almost be called lakelets, still in existence, are probably the last remains of these great lakes. These ponds, where they do not dry up in midsummer, swarm with a few species of fresh water shells, especially of the *Limnæs*, *Physæs*, and *Pianorbi*, which to me is a strong proof of this theory of their origin. The rising of the land continuing, the rivers began to cut new channels through the middle of the old lake-beds. This drained the marshes and formed the bottom lands, as the river beds of that period covered the whole of the present flood-plains from bluff to bluff. It was then that the bluffs which now bound these flood-plains received those touches from the hand of nature that gave them their peculiar steep and rounded appearance. Newer and more plastic, because less compactly bound and cemented together, the rains and floods easily molded them into those peculiar outlines which they have since preserved.

The Missouri, during the closing centuries of the loess age, must have been from five to thirty miles in breadth, forming a stream which for size and majesty rivaled the Amazon. The

Platte, the Niobrara, and the Republican covered their respective flood-plains in the same way. In the smaller streams of the State, those that originated within or near the loess deposits, such as the Elkhorn, Loup, Blue, and the Nemahas, we see the same general form of flood-plain as on the larger rivers, and no doubt their bottoms were also covered with water during this period. Hayden, in his first reports, has already expressed the same opinion as to the original size of these rivers. The gradually melting glaciers, which had been accumulating for so many ages at the sources of these great rivers, the vast floods of water caused by the necessarily moist climate and heavy rains, the present forms and materials of the river bottoms, are some of the causes which, in my opinion, would operate to produce such vast volumes of water.

The changes of level were not all upward during this period. The terraces along the Missouri, Platte and Republican indicate that there were long periods when this portion of the continent was stationary. Several times the movement was downward. Along the bluffs in the Republican Valley, at a depth varying from ten to thirty feet from the top, there is a line or streak of the loess mingled with organic matter. It is, in fact, an old bed, where vegetation must have flourished for a long period. It can be traced from Orleans upward in places for seventy-five miles. It indicates that after this bed had, as dry land, sustained a growth of vegetation, an oscillation of level depressed it sufficiently to receive a great accumulation of loess materials on top of it. Other oscillations of this character occurred previously to and subsequent to this main halt. These have already been discussed. I have also found traces of this movement in many other portions of the State.

The bases for speculation concerning the length of the loess age are of course uncertain, yet an approximate estimate may perhaps be made by comparison with the present deposits of the Missouri. The great lakes of the loess age extended, with a few interruptions, almost to the Gulf, and some of them cov-

ered an area of at least 75,000 square miles. Now, were all the sediment which is at present brought down the Missouri spread over such a vast area, the thickness of the deposit would be less than one sixteenth of an inch. Probably the yearly accumulations of sediment during the loess age amounted to that much, owing to the then greater volume of the Missouri and the aids to erosion from the greater prevalence of ice near its sources. In many places along the Missouri there are small lakes, formed from the old river-bed, where there has been a cut-off. Even where these little lakes receive the overflow of the river each year, it often requires at least a century to fill them up, even when aided by the sands which the winds waft into them. I have attempted to measure the sediment left by the river in these lakes, which are seldom half a mile in breadth, and it rarely amounted to half an inch in a season. The winds are a much more efficient agent for filling up small, narrow lakes, but in loess times, where there were such immense bodies of fresh water, their effects could only have been appreciable along the sandy shore-lines. The highest bluffs represent the original level of the loess deposits before the tremendous denuding agencies which removed so much of their materials had done their work."

But even with the aqueous theory of Prof. Aughey all the phenomena of the loess deposits of the Western States are not fully explained. On Richtofen's plan, of sub-aerial origin, the winds have merely lifted the light soil from one place and carried it to another. Its work could be only mechanical, leaving us unenlightened in regard to the deeper question of the chemical nature and origin of the loess.

Prof. Aughey's theory substitutes the transporting power of water for the persistent winds, and thus introduces another mechanical cause. In either case we are required to go beyond for the original source, and must dismiss Richtofen's theory as a splendid fabric of fancy. It is not altogether clear that these deposits are the contributions of one or several rivers

bearing into a great inland sea or gulf the detritus of the disintegrated cretaceous rocks from the west and north.

It is quite probable that the inland sea, whose shores are the limits of the loess, was itself so abundant in alkaline earths in solution, that large quantities of loess were deposited in the manner of limestone and dolomite, i. e. carbonate of lime and magnesia.

If we add to this the enormous quantities of soluble alkaline matter given off during long ages by means of the innumerable geysers of that geological epoch, it will render this explanation still more apparent, viz.: that the loess has to a great extent been precipitated, by chemical agencies, into the great inland sea of alkaline waters, according to processes that have long been familliar to chemists.

The gradual increase in thickness of the loess or bluff formations, from all directions, giving measurements from 5, 20, 50, and 70 feet to a depth of 150 and 200 feet, in the upper reaches of the Republican Valley, seems to prove that the great cretaceous sea contributing these deposits, not only extended to the farthest verge of this remarkable precipitate, but was deepest in the region towards the west. There are no advantages coming from this circumstance, and it is noticed here only as a remarkable fact. The deeper canons, made in the area of thickest deposits by the constant action of running water, renders certain portions of this region difficult for agricultural purposes; but the acreage thus grooved is a per cent. so small of the whole country, that it scarcely deserves mention as a deficiency.

Of many experiments, recently made by myself, testing the capacity of the loess of Nebraska soil to hold water, the following are good examples:

Experiment No. 1.—Ten pounds of surface soil, after a heated term of four weeks in August and September without rain, taken from a depth of 10 inches below the surface, on drying in a common oven, weighed 6 lbs. 8 oz.; loss in drying, 3 lbs. 8 oz.; ratio 56-160, or 7-20 weight of water, or a trifle over one-third which the soil contained at that time.

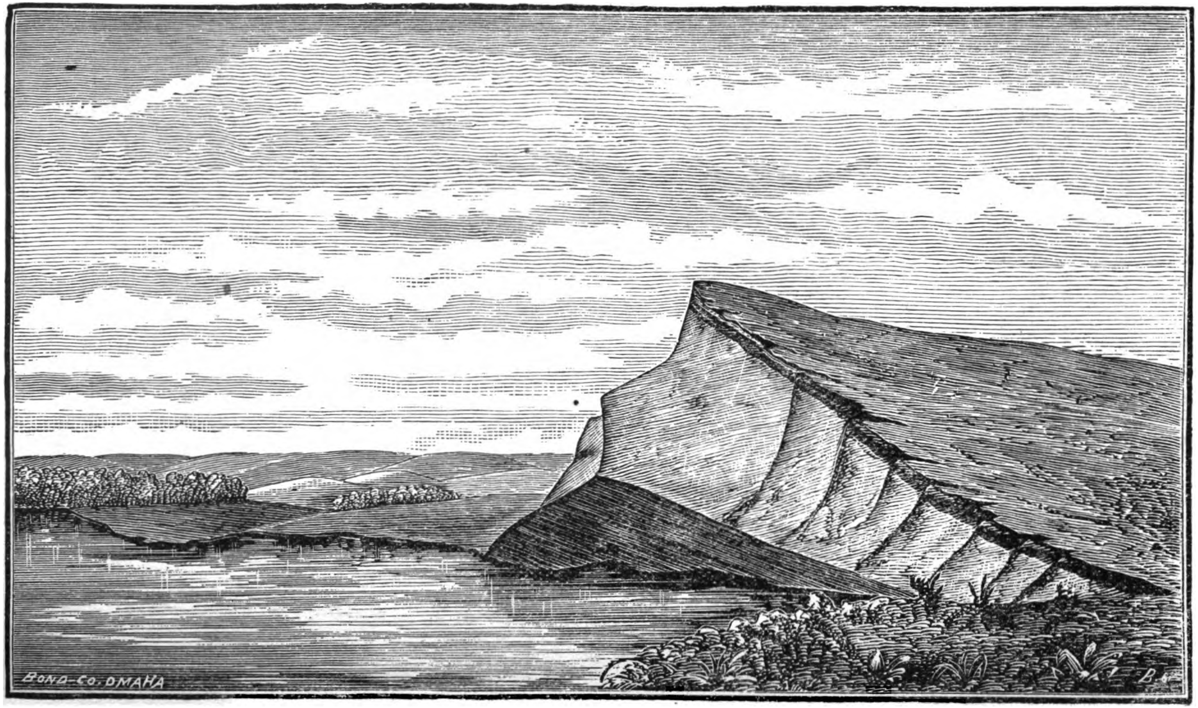


Plate No. 3.—FRANKLIN COUNTY, SOUTHWEST OF FRANKLIN STATION.
Showing: 1st, Top Soil; 2d, Subsoil; 3d, Rock Substratum.

Experiment No. 2.—I took 1 lb., and after pulverizing it permitted it to absorb water freely. The amount of water taken up was 6 ounces.

Experiment No. 3.—Another pound, left coarse as we find it in the field, absorbed 5½ oz. of water, showing the increased capacity of fine soil to hold water. An increase of 1 oz. of water to every 16 oz. of soil, conditioned upon its fineness, is a fact of great importance in thorough farming and gardening.

Experiment No. 4.—Two pounds of humus, or top soil, taken ten days after a rain from 6 inches below the surface from a wheat field on upland, weighed, after drying, 1 lb. 8 oz. This shows that the soil contained ¼ its weight in water.

Experiment No. 5.—At the same time 2 lbs. of subsoil, or loess of ordinary selection, on drying weighed 1 lb. 9½ oz., showing a loss of 6½ oz. of water; that in the loess contained 1-5 its weight of water.

Experiment No. 6.—I then took the same loess or subsoil, 1 lb. 9½ oz.—perfectly dry—and permitted it to absorb water to saturation. It took up 12 oz. of water, or nearly one-half its weight.

At the same time saturating the dry humus or top soil, I found (experiment No. 7) it had absorbed 12½ oz. of water, or over one-half its weight of water. The ratio in the loess was 25:12; in the humus 24:12½.

From these simple experiments, the following facts are obvious:

1. From experiment No. 1, that the ordinary amount of water held by the soil is equal to one-third of its weight.

2. The increased capacity of fine soil (equal to 1-16 weight of the soil), to retain moisture [No. 2 and 3] is equal to many thousand tons of water, taking a farm into consideration. It is a most convincing argument in favor of deep plowing and thorough preparation of soil.

3. By comparing experiments 1 and 4, it will be seen that the amount of moisture contained in the soil immediately beneath the surface is scarcely affected by the heat of summer months.

4. The comparative capacity of the top soil with subsoil to contain moisture, being in excess, indicates that cultivation gradually increases capacity for moisture, [No. 4 and 5].

5. The results seen in No. 6 and 7 form sufficient data for demonstrating the enormous capacity of these soils to contain water, while the other experiments prove their ability to retain water for a long period, whether received from melting snows or rains. Taken altogether they form an important chapter in the survey of the natural resources of a country not long ago believed to be an irredeemable desert.

Other experiments of a similar kind made in the Republican Valley and other parts of the State, gave the same results. Hence, they may be regarded as universal for loess soils. It was an interesting fact to notice that in all cases the absorption of water from below was much more rapid than the filtering or soaking downward (showing the power of capillary attraction, which is the power by which these soils retain their water,) is far greater than the power of gravitation by which waters drain away and escape. The constant supremacy of the capillary force over the power of drainage in these remarkable soils, is a perpetual guaranty that a farm once opened and exposed by deep plowing to several (four to six) years of saturating rains, can never afterward be injured by drouth.

In all cases where the loess—the common subsoil of Nebraska—is based upon subjacent sand strata, this power of capillary attraction must constantly compel waters from these sands toward the surface, so that there will be a general supply of moisture from this abundant source to take the place of evaporation. Many persons not understanding this principle have been surprised to see their gardens and orchards on high hills and ridges in vigorous growth through long periods of extreme dryness.

CHAPTER IV.

The Amount of Annual Rainfall in the Western States and Territories—Causes of Increasing Rainfall Westward from the Missouri River—Discussion of Theories: 1st, Rain Follows the Plow; 2nd, Prof. Aughey's Theory—The Increasing Absorptive Power of Soil Under Cultivation—Mr. Hilton's Views on the Rain Supply of Kansas.

HAVING shown in the foregoing chapter the extraordinary capacity of these soils to receive and retain large quantities of moisture, it follows next in order to describe the average amount of moisture annually received, and to set forth the causes of rainfall which is ascertained to be increasing west from the Missouri river on all parallels, by a definite amount or ratio for a series of year terms or periods. In approaching this important subject the writer is aware of the general debate on this question now before the public.

Throughout the West the people have generally accepted it as a fact that the area of increased precipitation is gradually extending toward the Rocky Mountains.

We admit as recent the dawn of this great truth, which, if established as a reality, implies not only a revolution of all preconceived notions in regard to the occupation of the Western plains, but also a reconstruction of the long-cherished plans of the founders of our government, who beheld in the Western Territories only a gloomy back-ground of constant care and trouble.

The purchase of the vast region from the French under Napoleon for $15,000,000, was advised, not so much on account of any agricultural or mineral value, but rather to obtain the right to establish our own frontier and provide our own means of defense against the impending dangers from the savage tribes of a wild and trackless desert.

But the steady westward march of the "Star of Empire" from the Atlantic toward the center of our National area has given rise to new constructions of our civil policy, and along with them, to closer examinations of the physical condition and actual resources of the great Territories.

The centralization of our government is determined by geographical laws and conditions, and not by the transitory dictation of commerce or Congress. The seat of government is at Washington, but the sceptre of power is firmly held in the grasp of the New West.

The Atlantic Slope is only our eastern frontier, and, based upon a physical law never to be repealed, our national rulers must in general be Western men. For these oracular decisions of our manifest destiny the reader is respectfully referred to the returns of the census of 1880.

What shall secure to an empire the permanency of its possessions? This was the first sentence of my first juvenile declamation. I have since ascertained that good soil, good society, grass and water have much to do in solving this political mystery.

That our ancestors should not only underrate but ignore the material resources of the West is very natural and excusable, because their attention was confined constantly to the narrow affairs of their own limited living, and in the Eastern States to-day large numbers of the present population still persist in shutting their eyes to the extraordinary enterprises for new homes and permanent business in the Trans-Missouri region; but we will attribute most of this disposition to the force of heredity.

At Fort Riley, near the mouth of the Republican River, careful observations were made, extending through a series of years, sufficient to determine not only the average amount of rainfall for each year but for each season, and also for term periods of years. The following table exhibits the record of observations for a period of 18 years:

TABLE FIRST.

Showing the monthly precipitation of moisture at Fort Riley, Kansas, from 1855 to 1872 inclusive. Elevation above tide water, 984 feet. Latitude, 39°. (Fall in inches and decimals):

MONTHS.	1855	1856	1857	1858	1859	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	Av each mo. for 18 years
January	.61	.06	.63	1.24	2.79	.70	1.38	.57	.48	.20	.80	.80	.03	.06	.51	.08	1.76	.02	.71
February ...	.25	.84	3.56	.05	.16	2.19	1.09	.60	.60	1.18	1.53	1.13	1.78	.06	2.19	.00	2.06	.69	1.10
March	.51	.68	.35	1.92	1.24	.10	.66	.68	.86	1.09	1.08	.86	.23	1.40	1.41	.76	.99	1.41	.90
April.	63	1.48	.81	3.75	.97	.13	1.21	1.73	2.02	.84	1.60	.79	2.86	1.30	2.66	.44	3.02	1.36	1.55
May	3.93	1.94	.91	3.20	3.70	1.16	4.92	2.52	3.25	.95	1.10	3.64	4.39	.79	1.56	1.68	4.53	4.06	2.67
June	5.06	4.55	1.20	5.30	1.96	3.04	6.73	1.78	4.96	1.88	5.47	3.61	7.19	2.69	5.45	1.11	1.19	2.08	3.62
July	2.13	3.40	5.20	4.66	1.40	1.13	5.48	2.92	6.62	2.28	2.80	7.00	5.84	1.49	6.83	1.74	7.38	7.19	4.19
August	4.30	4.00	4.37	4.10	5.84	1.82	1.50	1.89	5.71	2.45	3.27	1.42	.10	3.28	3.10	5.24	4.11	4.83	3.34
September..	6.52	1.10	3.07	1.66	1.17	2.21	6.30	2.55	.83	1.55	3.41	7.13	5.61	2.18	3.46	5.84	.79	6.74	3.47
October	.18	1.99	1.26	4.57	1.10	.23	1.42	1.70	.67	.16	2.92	.34	.27	2.28	.43	5.17	.93	2.53	1.56
November ..	1.80	1.96	1.34	.74	.77	2.40	.49	1.35	1.21	1.23	1.24	.94	.53	1.79	1.83	.07	4.71	.00	1.36
December ..	.49	1.93	.20	.75	.00	.78	.55	.82	2.52	1.20	1.20	2.78	.06	1.13	2.97	1.86	.32	.64	1.12
Total	26.41	23.94	22.90	31.94	21.10	15.89	31.64	19.11	29.78	14.91	26.37	30.44	30.89	18.43	32.40	23.99	31.79	31 55	25.59

Especial attention is called to the foreging and following tables, which present the average precipitation over a large area in the central portion of our domain.

After a thousand years of discovery, in France, Germany and England, the people still find new and valuable material in the common soil and rocks—a hint that in our country, also, there will be for a long time rewards for intelligent and persevering research; and a still stronger hint that the statements made and stereotyped a quarter of a century ago concerning the annual amount of moisture on the plains, and also concerning the agricultural prospects of Nebraska and the adjacent States, should be both reviewed and rewritten.

The annual average during the eighteen years, as will be seen, was 25-58 inches.

The table shows that the greatest rainfall is in the month of July, with nearly a uniform decrease from that month each way to January. About 56 per cent. of the annual fall is during the four principal months of crop growing, ending September 30th, that is, 14-62 inches in the four months. If May is included, the amount for the five months is 66 per cent., or about two-thirds of the fall for the year.

If we take the six years ending with 1872, the average fall for the three summer months was 11.81 inches, or within less than one inch of the average for the whole country, as shown by the general statistics on the subject.

To further illustrate the fact that that the rainfall is increasing with advancing years of cultivation, we make the following abstract from the above table, exhibiting the average annual rainfall during the eighteen years, divided into periods of six and nine years:

First period of 9 years	25.75
2d " " 9 "	26.75
1st " " 6 "	23.70
2d " " 6 "	25 36
3d " " 6 "	38.18

. As will be seen, each period gives an increased rainfall.

The most extensive and accurate series of observations on the specific and average amount of rainfall for eastern Nebraska through a long period of years was made by Dr. A. L. Child, of Plattsmouth. His records, most faithfully kept, date from 1861, and continue to the present. They may be taken as the standard or measure of precipitation for South-eastern Nebraska, between the valley of the Big Blue river and the flood plains of the Missouri, and extending along the fortieth parallel, from Brownville to Fairbury.

TABLE SECOND,

Showing the maximum, minimum, and mean temperature and total rainfall of months and years in Plattsmouth, Cass County, Nebraska:

Year.	December (1860).				January (1861).				February.			
	M'x	M'n	Mean.	R'n In.	M'x	M'n	Mean.	R'n In.	M'x	M'n	Mean.	R'n In.
1861....	....	....	22.60	1 00	....	....	18.10	....	....	....	23.00	....
1866....	....	....	19.50	1.00	....	...	16.60	1.35	68	—32	22.75	5.60
1867 ...	57	— 1	23,31	1.60	37	—10	14.49	1.84	52	—10	29.00	2..0
1868....	68	1	27.65	.85	52	—26	11.09	.85	66	—22	24.00	1.15
1869....	45	—30	19.35	2.10	49	— 2	23.38	1.30	63	—10	27.59	2.45
1870....	....	....	28 84	2.20	....	....	24.38	1.40	....	....	31.32	1.00
1871....	...	....	28.05	1.00	....	....	25.02	.65	....	....	31.50	1.60
1872....	....	....	20.04	.75	....	....	18.90	.30	....	....	29.30	.10
1873 ...	56	—20	16.80	2.10	47	—22	13.13	1.80	58	—10	23.90	.40
1874....	49	— 7	22.53	1.60	46	—14	19.92	.45	46	— 6	20.09	1.55
1875....	58	—10	25.58	.80	40	—21	7.71	.38	42	—21	11 56	.90
1876....	69	— 8	32.18	1.10	56	— 2	27.00	.06	68	—12	23.15	.94
187:....	59	—11	16.85	.07	58	—20	17.54	1.32	62	10	34.96	.42
1878....	60	2	37 07	1.73	51	— 1	27.20	1.69	62	5	33.76	.15
1879....	56	—11	19.50	.65	60	—24	19.27	.12	60	—10	26.05	1.12

Year.	March.				April.				May.			
	M'x	M'n	Mean.	R'n In.	M'x	M'n	Mean.	R'n In.	M'x	M'n	Mean.	R'n In.
1861 ...	....	....	42.30	....	....	....	47.20	....	....	....	59.00	....
1866....	71	— 1	29.44	2.30	93	12	51.61	3.19	91	30	60.20	2.85
1867....	45	—20	16.91	2.12	73	22	45.65	2.80	85	27	55.27	8.25
1868....	92	4	43.85	2.75	91	9	45.54	3.60	89	32	65.02	2.80
1869....	70	— 5	32.55	.60	80	15	50.16	2.45	92	29	60.59	6.15
1870....	....	....	32.57	1.00	....	....	54.56	2.70	....	....	67.05	5.80
1871....	....	....	42.80	.40	....	....	59 60	1.80	....	....	66.80	2.40
1872....	....	....	32.70	1 40	....	....	47.70	2.40	....	....	57.10	4.40
1873....	74	— 4	36.37	.70	78	26	45.22	15.90	89	41	59.11	19.00
1874....	60	7	32.15	2.51	88	12	44.65	4.09	92	38	67.48	3.15
1875....	72	— 3	29.11	3 38	84	20	44.81	4.62	96	35	71.00	3.98
1876....	60	— 4	27.92	2.09	83	30	51.12	5 16	88	35	63.73	3.10
1877....	75	0	32.46	1.01	79	32	49.27	5.88	88	35	59.06	7.57
1878....	81	19	46.74	3.09	83	31	53.95	4.01	81	32	57.49	5.54
1879....	85	1	40.78	2.15	80	12	52.32	2.17	91	34	65.84	5.94

TABLE SECOND—*Continued.*

Year.	June. M'x	June. M'n	June. Mean	June. R'n I'n	July. M'x	July. M'n	July. Mean	July. R'n I'n	August. M'x	August. M'n	August. Mean	August. R'n In	September. M'x	September. M'n	September. Mean	September. R'n In
1861...	..	..	71.60	......	....	....	78 30	......	164	40	74.31	7.40	92	30	62.93	8.20
1866...	95	88	68.01	5.93	100	46	77.80	2.80	101	34	72.32	3.22	85	26	57.32	5.65
1858...	92	42	72.33	3.15	96	43	75.32	4.70	97	45	75.05	1.70	65	32	66.58	1.55
1868...	94	45	72.03	5.00	106	50	83.68	3.00	90	50	69.50	6.30	86	25	57.33	2.35
1869...	90	52	68.70	9.05	92	45	73.30	7.50	94	50	75.19	8.00	85	29	62.00	5.20
1870...	..	..	74.20	2.10	....	....	82.10	2.00	....	....	69.90	3.66	..	..	66.30	6.60
1871...	..	..	76.60	2.30	....	....	76.40	14.10	....	....	74.60	3.30	..	..	62.20	1.30
1872...	..	..	73.06	4.70	....	....	75.17	7.40	....	....	74.52	90	..	..	62.37	4.10
1873...	94	60	75.08	4.80	196	59	75.54	6.40	105	49	77.98	1.00	95	28	61.27	2.20
1874...	94	44	74 31	18.02	13	55	82.[illegible]5	1.00	111	53	78.71	1.40	95	34	64.33	11.13
1875...	95	43	71.20	13.58	97	57	74.13	6.72	86	51	69.68	8.40	90	34	56.00	5.65
1876...	94	44	68.63	4.58	95	54	75.71	7.44	92	51	74.18	8.39	86	31	61.36	7.03
1877...	90	40	67.65	6.41	94	48	73.34	2.20	94	52	71.75	4.56	86	J0	65.44	2.37
1868...	86	45	66.39	9.64	94	55	7 91	11.61	95	52	75.27	1.23	88		63.02	3.36
1879...	90	41	70.51	5.05	94	56	[illegible]	3.10	94	50	73.71	2.16	91	31	61.65	2.12

Year.	October. M'x	October. M'n	October. Mean	October. R'n In	November. M'x	November. M'n	November. Mean	November. R'n In	Year. M'x	Year. M'n	Year. Mean	Year. R'n In
1861............	84	20	49.63	2.60	....	...	......	....	....	....	......	....
1866............	86	14	53.08	00	74	6	38.75	1.65	101	—32	47.53	31.70
1867............	87	22	52.24	1.05	78	—7	39.90	.05	97	—20	46.67	31 51
1868............	85	22	49.67	1.90	75	9	33.92	1.90	106	—26	48.84	87.85
1869............	82	10	42.07	.75	....	....	35.26	1.40	94	—30	47.42	47.35
1870............	....	....	53.60	2.30	....	....	42.09	.00	....	....	46.61	32.10
1871............	....	....	53.69	1.20	....	....	34.00	3.20	....	....	46.82	32.25
1872............	....	....	50.91	4.00	....	....	30.91	.70	....	....	45.69	31.35
1873............	89	15	48.16	1.60	75	8	36.95	.45	105	—22	47.58	49.45
1874............	79	18	54.14	2.11	76	7	34.81	1.80	113	—14	49.81	49.71
1875............	79	21	48.86	1.32	72	—8	30.68	01	97	—21	45.09	46.72
1876............	77	10	48.87	.71	69	0	31.26	2.14	95	—17	49.20	42.74
1877............	86	27	49.68	7.11	61	– 3	33.96	1.70	44	—20	47.77	40.62
1868............	84	11	51.06	.71	69	13	41.85	.71	95	— 2	52.64	43.47
5879............	87	19	59.54	1.99	68	7	37.90	5.36	94	—34	50.41	31.93

Dr. Child concludes his very valuable Report on the Progress of the Seasons, as follows:

"As seen by the table of Temperature and Rainfall, for fourteen years past, the extremes are from 32° below zero in February, 1866, to 113° in July, 1874, a range of 145°

"The extremes of heat in July and August, 1874, however, were exceptional, with narrow currents of heated air which more frequently scourge Western Kansas. They have never reached us, except on two occasions of July 25 and August 10, 1874. Setting aside these two cases, our extremes of heat are from 100° to 106°. In the mean temperature of the years there is no perceptible increase or decrease since these records were commenced —22 years since.

"In the matter of rainfall and melted snow, passing over the theories and speculations of the day, or increase or decrease from cultivation, increased timber growth, or denudation, the table on Temperature and Rainfall, embracing a perion of fourteen years, gives us some interesting facts.

"A glance at the last column of 'yearly rainfall' presents a mixed and confused mingling of increase and decrease as the years pass on, from which it is not easy to come to any definite conclusion on the subject. But if we divide the fourteen years into periods of three years each, we have four full periods and two years of a fifth period. The sum of the first period is 101.06 inches; of the second, 111.70; the third, 130.51; and the fourth, 130.08.

"Here is an increase in two periods in their order of 10.64 and 18.81 inches; and the third keeps up with this whole increase of 29.45, lacking .49. There must, of course, be a limit to this increase. When we shall have reached this limit, further observation only can decide. The year 1879 has fallen back into company of 1866 and 1867; but so did 1872. Yet 1873 fully made up the lack of 1872, and 1880 may, or may not, make good the deficiency of 1879. One very important point will be noticed in the column of the *mean* rainfall of each month, and that is that far the largest portion of our rainfall occurs during the growing season of vegetation, just when it is most desirable."

Hon. S. R. Thompson, Superintendent of Public Instruction, and Director of the Nebraska Weather Service, also contributes a series of interesting observations. (Tables III, IV, V, VI and VII).

He remarks with characteristic caution:

"Many persons are ready to furnish attractive and plausible theories of the changes our climate has undergone since the settlement of the State; but when you seek for the facts and observations on which such opinions are or ought to be founded, they are difficult to find; and when found seem hardly to justify the confident generalizations made from them.

"If the volunteer weather service can be continued for the years to come it will furnish data for the study of the climate of our State on which we can base conclusions of value."

Table III gives all the reliable records as far back as 1864. A few of these are fragmentary, but most of them are continuous.

Table IV is compiled principally from Table III, and is equally trustworthy.

Table V is given to enable persons who do not have access to monthly records of rainfall in other States to compare them with ours.

The observations given have been taken at random from the large number of such accessible.

TABLE THIRD.

Rainfall in Nebraska by Stations and for months for sixteen years.

PLACES	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1864													
Bellevue	0.41	....	....	2.40	1.32	2.86	0.74	1.48	1.77	4.23	1.45	0.34	......
1865													
Bellevue	0.13	0.04	0.25	2.65	1.45	5.05	3.72	....	1.31	3.32	....	1.39	23.26
Nursery Hill	0.30	7.75	3.86	6.73	2.94	......	......	....	......	....	....	....	......
1866													
Bellevue	2.05	0.40	0.66	1.37	1.91	5.27	1.52	1.46	5.90	0.34	1.33	1.51	23.72
Plattsmouth	1.35	0.60	2.30	3.19	2.85	5.93	2.80	3.22	5.65	....	1.65	1.00	30.54
1867.													
Elkhorn	2.28	1.05	1.83	......	....	......	......	....	......	....	0.05	0.35	......
Bellevue	1.80	2.44	....	1.78	5.38	......	......	....	......	....	....	....	......
Plat smouth	1.84	2.70	2.12	2.80	8.25	3.15	4.70	1.70	1.55	1.05	0.05	0.85	30.76
De Soto	....	....	....	......	8.20	5.48	3.50	1.39	1.82	1.07	0.03	0.62	......
1868.													
Plattsmouth	0.85	1.55	2.75	3.60	8.20	5.00	8.00	6.30	2.85	1.90	1.90	2.10	39.60
De Soto	0.70	0.79	2.74	3.16	4.52	4.13	3.30	2.65	3.27	0.82	1.18	2.00	29.26
1879.													
Nebraska City	1.15	2.60	1.05	3.05	4.50	8.88	7.50	6.60	6.05	5.30	2.05	2.28	51.01
Omaha Mission	0.13	1.65	0.30	2.90	2.00	4.75	4.27	4.06	7.83	1.10	1.50	2.36	32.85
De Soto	0.60	1.48	0.28	1.64	3.29	7.13	8.60	6.25	9.74	0.80	1.13	3.63	44.57
Plattsmouth	1.30	2.45	0.60	2.45	6.55	9.05	7.50	8.00	5.20	0.75	1.40	2.20	47.35
1870.													
De Soto	0.35	0.01	1.36	0.62	4.95	0.89	4.35	2.39	6.79	0.88	0.07	0.13	22.79
Omaha	2.50	....	1.95	1.00	7.68	0.72	2.54	1.53	4.46	0.77	0.10	0.53	23.58
Bellevue	0.40	....	1.00	2.70	5.80	2.10	2.00	3.60	6.60	2.32	....	0.10	26.62
Nebraska City	1.74	....	2.15	2.00	2.80	1.00	2.63	4.10	7.10	2.55	0.20	0.17	26.44
Plattsmouth	1.40	1.00	1.00	2.70	5.80	2.10	2.00	3.66	6.60	2.30	....	1.00	32.10
1871.													
De Soto	0.51	1.37	0.20	3.13	1.13	3.30	8.29	1.63	3.41	1.18	3.82	1.38	30.05
Omaha	0.60	2.07	0.23	3.38	1.90	2.70	9.89	2.58	2.73	2.06	4.24	0.91	33.29
Plattsmouth	0.65	1.60	0.40	1.80	2.40	2.30	14.10	3.30	1.30	1.20	3.20	0.75	32.25

TABLE THIRD—*Continued.*

PLACES	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1872.													
De Soto	0.21	0.36	1.68	2.83	6.83	2.56	6.56	2.49	4.19	3.15	1.05	0.28	32.19
Omaha	0.09	0.58	1.61	2.84	6.35	3.91	6.36	1.78	3.24	3.89	0.87	0.11	31.53
Plattsmouth	0.30	0.10	1.40	2.40	4.40	4.70	7.40	0.90	4.10	4.00	0.70	2.10	31.85
1873.													
De Soto	1.21	0.19	0.45	2.69	3.42	4.01	3.09	1.14	0.95	1. 9	0.06	0.78	19.48
Omaha	0.64	0.02	0.44	3.83	5.59	5.86	4.27	1.60	1.86	1.82	0.19	0.92	27.50
Plattsmouth	1.60	0.60	0.60	15.90	9.00	4.80	6.40	1.00	2.20	1.60	0.45	1.60	49.45
1874.													
De Soto	0.34	1.20	1.21	1.94	1.66	5.01	2.35	1.54	5.55	2.01	4.39	0.62	24.82
Omaha	0.32	0.92	1.49	2.01	1.24	6.93	0.54	2.08	7.18	1.45	1.05	0.54	25.73
Plattsmouth	0.65	1.55	2.51	4.09	3.15	18.02	1.10	1.40	11.13	2.11	1.80	0.80	48.31
1875.													
De Soto	0.48	1.31	2.80	2.50	4.31	5.70	5.62	8.45	3.67	0.86	0.90	2.01	38.61
Omaha	0.26	0.51	1.24	3.06	4.25	10.95	10.01	7 77	2.55	1.16	0.13	1.00	42.89
North Platte	0.24	0.26	0.40	6.21	1.69	1.62	2.11	0.66	1.40	0.14	0.52	0.09	15.38
Plattsmouth	0.38	0.90	3.38	4.62	3.98	13.58	6.72	8.40	5.63	1.32	0.01	1.10	50.02
1876													
De Soto	0.36	1.58	1.66	1.30	1.75	2.92	9.42	6.89	7.31	0.46	0.97	0.23	34.85
Omaha	0.22	0.40	3.18	2.65	2.07	3.47	7.30	6.27	4.93	0.69	1.17	0.16	32.57
North Platte	0.09	0.13	0.49	0.51	2.97	0.49	1.18	2.46	1.47	1.07	0.49	0.51	11.84
Plattsmouth	0.06	0.94	2.09	5.16	2.10	4.58	7.44	8.39	7.03	0.71	2.14	0.07	41.71
1877.													
De Soto	1.27	0.60	0.73	5.04	8.06	4.10	1.78	3.94	1.74	3.55	0.80	1.69	33.80
North Platte	1.38	0.37	0.19	0.37	3.22	2.99	2.04	6.03	4.49	1.23	0.30	3.86	25.47
Omaha	0.53	0.44	1.26	6.24	8.63	8.36	0.96	3.13	2.05	5.86	1.36	5.04	40.95
Plattsmouth	1.32	0.42	1.01	5.84	7.57	6.41	2.20	4.58	2.37	7.11	1.70	1.73	42.25
1878.													
De Soto	0.98	0.18	2.13	1.90	7.36	7.27	5.71	3.85	1.71	0.56	0.49	0.28	32.42
Omaha	1.13	0.14	3.09	3.97	5.77	8.48	7.66	2.48	3.22	0.55	0.29	0.27	37.05
North Platte	....	0.18	1.40	1.15	3.25	5.85	3.58	1.52	0.91	0.13	0.46	0.20	18.62
Plattsmouth	1.69	0.15	3.09	4.01	5.54	9.64	11.61	1.23	3.36	0.71	0.71	0.65	42.39
1879.													
Weeping Water	....	0.50	1.25	1.61	2.00	4.85	4.75	0.75	1.75	2.78	4.88	1.47	26.61
Pawnee City	0.21	0.25	0 38	1.11	2.87	4.20	3.97	1.38	2.43	1.83	7.20	1.00	26.83
Beaver Creek	0.65	0.50	0.05	2.87	3.15	5.02	11.80	1.10	2.10	0 50	0.75	0.17	28.66
Plattsmouth	0.12	1.12	2.15	2.17	5.94	5.06	3.10	2.16	2 12	1.99	5.30	1.39	33.06
Utica	....	0.44	....	2.53	6.49	5.94	8.63	1.63	0.77	....	2.25	2.54	30.22
Table Rock	0.57	0.44	0.48	1.88	1.85	4.95	3.02	3.09	4.70	0.50	8.11	1.12	27.71
Cedar Bend	0.40	0.42	0.05	0.42	2.00	[illegible].31	3.06	1.90	2.55	1.88	8.75	0.80	21.54
Kearney	0.77	0.50	0.05	2.87	3.15	5.02	11.80	1.10	2.10	0.50	0.75	0.17	2 .78
Stowe	0.77	0.25	3.06	2.75	1.33	3.79	1.95	0.94	2.05	....	0.45	0.23	17.57
Omaha	0.07	0.93	2.17	1.17	5.53	4.09	2.17	1.51	1.43	3.64	4.25	1.25	29.71
North Platte	2.33	0.43	0.11	1.93	2.25	3.31	8.47	0.[illegible]6	0.40	0.21	0.10	0.37	20.07
Sterling	0.22	0.60	1.08	1.80	3.07	5.22	4.65	6.70	2.35	2.05	3.75	0.89	32.38
Fremont	0.1[illegible]	1.37	2.10	3,38	4.61	5.26	2.03	3.53	0.70	3.68	1.54	0.91	29.65
Inavale	1.25	0.25	0.05	2.75	.20	3.50	6.50	0.90	2.0	....	1.10	0.75	23.25
Palmyra	....	0.44	0.48	1.21	3.05	3.07	3.85	0.55	1.25	0.89	4.04	0.95	19 78
De Soto	0.15	0.85	1.43	1.77	4.06	5.17	2.08	1.76	0.92	4.22	1.56	1.20	25.17

TABLE FOURTH.

Rainfall. Average of records at differnt stations for each year, from 1865 to 1869.

YEAR.	No. of Stations	January	Feb'y.	March	April	May	June	July	August	Sept.	October	Novem.	Decem.	
1865	2	0.22	5.87	2.06	4.69	2.19	5.05	3.72	....	1.31	3.32	....	1.89	29.82
1866	2	1.70	0.50	1.48	2.28	[illegible]	5.60	2.16	2.34	5.77	0.17	1.49	1.25	27.12
1867	4	1.97	2.06	1.87	2.29	7.28	3.85	4.10	1.55	1.69	[illegible]	0.04	0.73	28.49
1868	5	0.85	1.15	2.75	3.60	8.20	5.60	[illegible]	[illegible]	2.85	1.90	1.90	2.10	39.60
1869	4	0.70	2.14	0.56	2.51	4.08	7.45	6.97	6.23	7.70	1.98	1.52	2.76	43.94
1870	5	1.27	0.20	1.49	1.80	5.41	1.36	[illegible]	3.00	6.20	1.76	0.08	0.38	26.31
1871	3	0.65	1.68	0.27	2.74	1.81	1.76	10.76	2.50	2.48	1.48	3.75	1.01	31.86
1872	3	0.19	0.34	1.51	2.62	5.43	4.31	6.88	1.35	3.67	3.95	0.78	1.10	31.86
1873	3	1.12	0.31	0 52	9.87	7.29	5.33	5.34	1.30	1.93	1.71	0.34	1.26	31.81
1874	3	0.48	1.24	[illegible]	3.05	2.24	12.48	0.82	1.74	9.16	1.78	1.43	0.67	32.95
1875	4	0.40	0.56	1.67	4.63	3.31	8.72	6.28	5.61	3.19	0.87	0.22	0.73	36.74
1876	4	0.13	0.49	1 92	2.94	2.71	1.85	5.30	5.71	4.37	0.82	1.26	0.25	30.24
1877	4	1.08	0.48	0.82	4.15	6.43	5.92	1.73	4.24	2.96	4.73	1.12	2.57	35.62
1878	4	0 94	0.16	2.53	3.04	4.92	7.99	7.62	1.74	2.49	0.46	0.47	0.37	32.59
1879	22	0.71	0.62	0.91	2.35	3.98	4.89	5.53	2.15	2.14	1.32	2.27	0.85	27.38

TABLE FIFTH.

Rainfall in other States. Average of many years.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Plattsmouth, Neb., 13 years	1.03	1.55	1.79	4.50	5.45	6.87	5.92	4.01	4.52	1.90	1 21	1.76	46.51
Rochester, N. Y.	1.88	1.40	1.81	1.97	3.04	3.25	3.01	2.60	3.05	3.39	2.94	2.70	30.49
Milwaukee, Wis	1.30	0.80	1.60	2.40	2.50	4.00	3.00	2.90	3.20	1.40	2.10	2.00	27.20
Pittsburg, Pa.	2.18	2.17	3.70	3.10	3.58	3.56	2.97	3.34	2.68	2.87	2.68	3.13	34.96
Cambridge, Mass	2.39	3.19	3.47	3.54	3.74	3.13	2.57	5.47	4.27	3.73	4.57	4.31	44.48
De Soto, Neb., 12 yrs.	....	....	....	....	....	....	....	....	....	....	....	......	....

THE RAINFALL OF 1878-9.

In the following table is given the results of the observations of the weather service for six months of 1878 and the whole of 1879, by months. For purposes of comparison, are given in parallel columns the rainfall records of the United States Signal Service stations at Omaha and North Platte; the former of these stations being on the eastern side of the State, and the latter further west than any station of the state weather service.

It will be understood that "E. Half" means average of all stations east of the sixth principal meridian, and "W. Half" all west of that line.

TABLE SIXTH.

Rainfall of 1878-9.

1878.	Omaha.	E. Half.	W. Hal .	N. Platte.
July	7.66	7.43	3.64	3.58
August	2.48	2.00	2.00	1.52
September	3.22	3.22	0.19	0.91
October	0.55	0.40	0.18	0.13
November	0.29	0.40	0.75	0.46
December	0.27	0.54	0.38	0.20
Six months	14.47	13.99	7.14	6.80
1879.	**Omaha.**	**East.**	**West.**	**N. Platte.**
January	0.07	0.67	0.89	2.33
February	0.93	0.44	0.93	0.43
March	2.17	0.75	0.10	0.11
April	1.77	2.00	2.35	1.93
May	5.53	3.22	4.52	2.25
June	4.09	4.88	5.46	3.31
July	3.17	4.40	7.60	8.47
August	1.51	2.31	1.30	0.15
September	1.43	2.40	2 00	0.40
October	3.64	2.24	0.50	0.21
November	4.25	4.42	1.33	0.10
December	1.75	1.22	0.60	0.37
Year	30.31	28.95	27.67	20.07

TABLE SEVENTH.

Rainfall of 1879, by sections of Nebraska.

1879.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Southteastern part	0.21	0.44	0.56	1.60	3.03	4.99	5.53	2.12	2.09	1.77	5.09	1.10	27.53
South-western part	1.27	0.25	1.12	2.75	5.53	4.71	6.47	1.10	2.50	0.29	1.76	0.61	30.39
North-eastern part	0.10	1.37	1.86	2.57	4.33	5.00	2.05	1.64	1.79	2.92	1.07	1.29	26.99
North-western part	1.25	0.43	0.09	2.49	3.03	3.85	8.07	1.75	1.78	0.28	1.17	0.42	24.61

The rain belts adopted in Kansas, are based upon altitude above sea level. The first belt includes the areas of altitude less than 1,000 feet; the second belt, areas over 2,000 feet; the third belt, all areas over 3,000 feet. These divisions show a gradation of rainfall dependent upon altitude, or density of atmosphere. Whatever may be the average increase of annual rainfall, the comparisons from year to year should be made upon areas of equal or similar altitude. Another natural division of precipita-

tion was based upon the relative amount for each of the four seasons. This division is of special importance in showing that universally in the West the amount of rainfall is greatest when most needed, and vice versa.

Tables representing these natural divisions and measures of moisture based upon years of observation in Kansas have been arranged for the 40th Parallel—the boundary between Kansas and Nebraska.

The first belt, 1,000 feet above sea level, includes in Nebraska the larger portion of Richardson, Nemaha, Otoe, Cass, Sarpy, and Douglas counthe east line of Pawnee county; the second belt (1,000 to 2,000 ties, but does not extend on the 40th Parallel farther west than feet) includes the country between the east line of Webster county and the east line of Pawnee county; the third belt (2,000 to 3,000 feet), all the region west from Webster county, to the western limit of Red Willow county.

Diagram A, showing the relative amount of rainfall in the first, second and third belts in the growing months of March, April, May and June of 1877 and 1878. Fortieth parallel, or southern boundary of Nebraska:

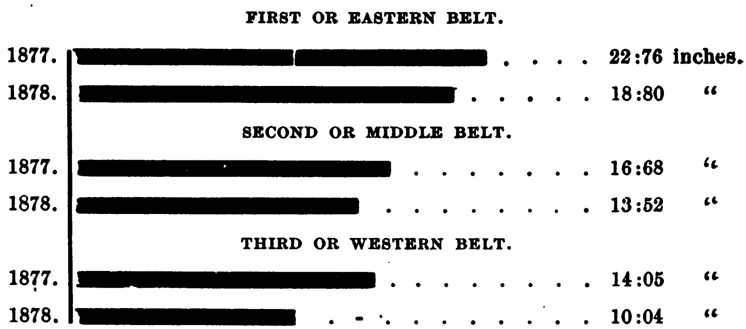


Diagram B, showing the relative amount of rainfall in the first, second and third belts in August, September and October

of each year, when most required for winter wheat. Fortieth parallel, or southern boundary of Nebraska:

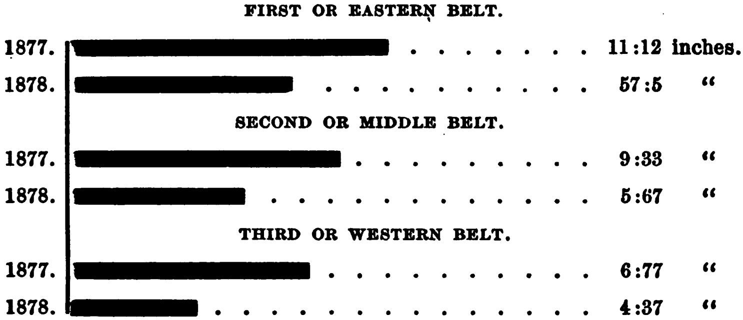
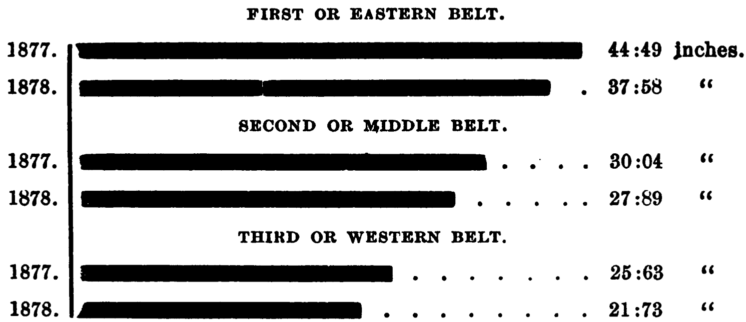


Diagram C, showing the mean rainfall for the years ending October, 1877 and 1878. Fortieth parallel, or southern boundary of Nebraska:



Sources of Moisture.

It is a well settled fact that the great mass or proportion of rain which falls annually in the interior of the continent has been borne thither by the invisible winds from the great bodies of water which are in the direction of the prevailing atmospheric currents. As the meteorologists do not agree in regard to the direction of the great currents of air, so they would not agree as

to the sources of water raised by evaporation and carried or distributed to various portions or areas of the continent.

Both Maury and Guyot refer to the Southwest Pacific as the source of moisture, by which winds are supplied which transport it far to the northeast, where it precipitates upon the plains of Kansas and Nebraska. A recent writer, whose views are given at length on this subject, transports most of our rain supply from the Gulf of Mexico. They do not thus far appear to be any more definite or positive in their conclusions than the inquisitive boy who cut open the hand-bellows to see where the wind came from.

But it is certain that all water surface must constantly, by evaporation contribute an amount of vapor, in proportion to their areas which are constantly swept by the changing winds.

The amount of water taken up or evaporated will be modified both by the temperature and dryness of the passing winds.

We are obliged therefore to consider all bodies or surfaces of water, as aids in furnishing moisture to the surrounding atmosphere. This will include, in addition to the usual catalogue, the rivers, creeks, lakes, ponds, marshes, and also all bodies of melting snow and ice. It should be added, that running water evaporates more rapidly than when at rest—a fact which affords a partial explanation why showers appear to follow the courses of rivers, and even smaller streams.

With a long-continued wind from the direction of any large body of water, such as the Gulf of Mexico, or the Pacific Ocean, the atmosphere over any given area must become more and more saturated, until only slight changes in the the temperature will induce the requisite amount of condensation for rain.

I would prefer to say that our rain material comes mainly from the Gulf of Mexico. First, it is only 800 miles distant; 2nd, it is the direction of the south winds; 3rd, there are no barriers of mountains or sandy plains to obstruct the winds or dissipate the moisture with which they were laden at the start.

But it should be borne in mind that the moist surface of the

earth itself constantly yields moisture to the superincumbent atmosphere, in quantities that almost transcend belief when we measure the amount daily taken up from a section, or even an acre of land.

In cases of local rains, this source of moisture must always be considerable. A large area of saturated soils, extending over several counties appears to have, from this cause, the power to perpetuate rainfall. It rains without effort, as if rain could become a habit. On the other hand, a large tract of dry land extends and perpetuates dryness. Its influence reaches far beyond its own heated boundary, and dismisses into viewless air the advance of the great army of clouds marching in from any direction. The desert thus has a tendency to establish itself. The greater the area of sand surface the greater in quantity is the radiant heat produced. It heats a still greater amount of atmosphere, and with added force forbids the condensation of moisture, or the forming of clouds, which precede precipitation.

In like manner cold produces and prolongs the cold term, as when the snows simultaneously cover the Northern and Westarn States and Territories. Passing over this immense area the winds become charged and involved with cold, which is not mitigated until the so-called polar wave has reached far into the South, where the sun is able to temper it with opposing influences. If the first snows are deep over the vast area referred to, the acute observer will naturally predict a long and steady cold winter, and gain some credit as a weather prophet over people who never thought so far.

So, too, the presence of an extraordinary body of snow accumulating for a half-year throughout the ranges and in the valleys and canyons of the Rocky Mountains, will not only produce what is called a backward spring upon the plains of Nebraska and Kansas, but will, later in the season, cause not only heavy floods from overflow of the mountain streams, but frequent and unusual rainstorms that will continue until later in the autumn.

In the winter of 1879-80 the snowfall was unprecedented in

the western half of the mountain district. It covered the entire range from Arizona, extending north, N. E. and N. W. beyond the British possessions.

It was equal in dimension to a great sea of low temperature, 3,000 miles in length, by an average breadth of 300 miles. It is now (July 1880) surrounded by a summer atmosphere of high temperature, which, by rapid evaporation and melting, sends large quantities of moisture into the upper air and a vast amount of water to the streams and rivers of the plains below. From these causes unusual rains and floods, though late, are inevitable.

The uniformity, or sameness of the annual average rainfall, doubtless depends more upon local evaporation than any other cause. But it is only when an extensive country has reached its plenum, or fullness of rain conditions that we can predicate this uniformity.

Illinois, for instance, which is now entirely occupied with a uniform vegetation of grasses, crops and groves, and is for several hundred miles, on all sides, surrounded by the same causes of condensation, has five belts of rainfall which are nearly constant for successive years.

1.	Northern Illinois receives annually 35 inches of rain.				
2.	Northern Middle Illinois	40	inches	of	rain.
3.	Middle "	45	"	"	"
4.	Southern Middle "	48	"	"	"
5.	Southern Ills., (Cairo)	50	"	"	"

It makes but little difference in Illinois from which direction the wind comes; it is quite certain, with a slight reduction of temperature, to bring rain. It may require many years in Nebraska and Kansas, and in the western States and Territories generally, to have established such a complete basis for the uniformity of rains. Meanwhile we can adapt our agriculture to the periodic rains, and with thorough farming achieve abundant success.

The vast open area to the south-west, viz: Southern Colorado, New Mexico and Arizona, has been for ages the principal

source, as well as direction, of our dry winds, which still prevail, especially in the autumn months, and occasionally in the spring. But they appear already to have become considerably modified in severity as well as duration. The rapid extension of prairie and other grasses in that direction, together with the gradual development of the country by means of railroads, towns, farms and ranches, will still further secure the plains of western Kansas and South-western Nebraska from the warm and sultry winds. "It is certain," says a recent writer, "that rains have increased; this increase has coincided with the increase of settlements, railroads and telegraphs. If influenced by these, the changes of climate will go on; if by extra mundane influences, the change may be permanent, progressive or retrograde. I think there are good grounds to believe it will be progressive. Within the last fifteen years, in Western Missouri, Iowa, Eastern Kansas and Nebraska, a very large aggregate of surface has been broken up and holds more of the rains than formerly. During the same period modifying influences have been put in motion in Montana, Utah and Colorado. Very small areas of timbered land west of the Missouri have been cleared, not equal, perhaps, to the area of forest, orchard and vineyards planted. Hence it may be said that all the acts of man, in this vast region, have tended to produce conditions ameliorative of the climate.

"With extended settlements on the Arkansas, Canadian and Red rivers of the south, as well as on the river system of the Kaw, including the great Republican river; and on the Platte, the ameliorating conditions will be extended in like degree; and it partakes of sober reason to suppose that a permanent and beneficial change of climate may be experienced.

"The appalling deterioration of large portions of the earth's surface, through the acts of man in destroying the forests, justifies the trust that the culture of taller herbage and trees, in a region heretofore covered mainly by short grasses, may have a converse effect. Indeed, nature seems to almost precede settlements by a change of herbs and grasses."

After a careful comparison of the foregoing factors of the interesting problem whose full solution shall be explanatory of the causes of the gradually increasing rainfall westward from the Missouri river, we are quite certain that

IN THE WESTERN PROGRESS OF AGRICULTURE,

will be found the ultimate cause of this established fact.

It is conceded that large tracts of desert, whether of sand or rock surface, when exposed to the sun are void of the conditions that naturally induce rainfall. It is also evident that the exceedingly sparse grasses that once covered the entire region west of the Missouri river did not, except in a limited degree, shield the earth from the fierce heat that without intermission poured down upon these plains. While the Buffalo grass is very nutritious, and available at all seasons of the year, it does not occupy more than one-twentieth (1-20) of the surface, leaving in reality nearly the entire soil as much exposed to the torrid sun, as a meridian street of St. Louis or Cincinnati in mid-summer. Buffalo grass is at best only a compromise between a desert and a meadow, but it is at the same time a witness and proof, by its rapid disappearance, that the desert is a thing of the past.

The leaf itself, or blade of buffalo grass, short, rounded, small, like the leaf of the pine or spruce, shows its adaptation to the climate of the past. So perfect is the correlation that we cannot expect these grasses to exist, or even be modified with any important physical change in their surroundings. It is on account of the inability of buffalo grass to adapt itself to the increasing moisture that is has already retreated westward several hundred miles, and as every farmer in Nebraska and Kansas knows, is now being supplanted by the long-stemmed, wide-leaved prairie grasses. The existence of these last named grasses in their very nature or constitution, indicate a sustained increase of moisture, by a decided amount. They are themselves a positive proof, to the extent of this retreat or exchange of grasses, that a new era of moisture has begun to overspread the Western plains.

During a period of less than 15 years the writer of these pages has witnessed this hegira or march by day and night, of the prairie grasses for a distance of 150 miles. This receding of buffalo grass or overtopping of the prairie grasses, can be seen not only in all the valleys and over all the divides of the Republican river, but everywhere on the same parallel of longitude in both Nebraska and Kansas. Nor is there any evidence of a halt, nor even a lingering or a lessening of the rate of encroachment. Nor can any one properly say that the primitive or buffalo grass, will not continue its western retreat entirely across the plains.

The increasing moisture cannot, as before mentioned, expand the tiny leaf, nor re-construct the filiform roots of these primitive grasses, but it can, and does supply condicions essential to the more succulent, luxurious, and rapidly-growing grasses following closely the line of this retreat.

We come therefore to this proposition, viz.: That the cause, or causes of this change in vegetation are also moving in the same direction, from east to west, with a rate nearly uniform with the above described effects.

It is readily admitted that along the Missouri river (east side), a belt of 50 miles in width, extending from Kansas City to Yankton, has already become nearly uniform with cultivated fields, and it is also a matter of record that precipitation or rainfall over this area has a corresponding uniformity. The same has become true with only a trifling difference in the amount of annual rainfall for a belt of the same dimension on the west side of the same river in Kansas and Nebraska, in which cultivation has reached about the same status. In either instance the average rainfall is nearly the same as in Northern Illinois; but in the latter instance the now productive area was, by the united testimony of hundreds of early settlers, so arid for the first few years of occupation that the Big Blue river was firmly regarded as the desert boundary. A good business man, 15 years ago in Nebraska City, refused a very liberal offer to establish a store at Seward, saying

that this country would always be so dry that agriculture could never be a success, and therefore a mercantile business man could never prosper as far west as Seward. He has since become a merchant in the same valley. He has seen, in less than 20 years, the rains establish their annual regularity in the beautiful valley of the Big Blue, which was then quite as unpromising as any portion of the Upper Republican Valley.

Suppose now that a new army of frontier farmers--as many as could occupy another belt of 50 miles, in width, from Manitoba to Texas, could, acting in concert, turn over the prairie sod, and after deep plowing and receiving the rain and moisture, present a new surface of green, growing crops instead of the dry, hard-baked earth covered with sparse buffalo grass. No one can question or doubt the inevitable effect of this cool condensing surface upon the moisture in the atmosphere as it moves over by the Western winds. A reduction of temperature must at once occur, accompanied by the usual phenomena of showers. The chief agency in this transformation is agriculture. To be more concise. *Rain follows the plow.*

CHAPTER V.

THE ANNUAL RAINFALL—*Continued.*

Rain Follows the Plow.

By the repeated processes of sowing and planting with diligence the desert line is driven back, not only in Africa and Arabia, but in all regions where man has been aggressive, so that in reality there is no desert anywhere except by man's permission or neglect.

By neglect, the Valley of the Euphrates, one of the sources of supplies of a vast empire, and enjoying the highest cultivation, has become a desert.

The vision of the prophet has been verified; "It shall not be dwelt in from generation to generation; neither shall the Arabian pitch tent there; neither shall the shepherds make their fold there. But the wild beasts of the desert shall lie there, and shall cry in their desolate houses, and owls shall dwell there, and satyrs shall dance there."

Palestine is now comparatively a desolation, for the simple reason that the gardener's occupation is gone. It once sustained, as we are credibly informed, a vast population. Nor is there any doubt that both these noted valleys can be brought back to their former productive ability by applying the same means that have been so long neglected.

While in modern times, we had either lost sight of or had never known the relations of rainfall to agriculture, it is very clear that in the earlier period of human history this great fact was at least recognized. Thus, in the Mosaic record, agriculture, or tilling the ground, is mentioned as the direct cause of converting dew, or mist, into rain:—

"But there went up a mist (dew) from the earth and watered the whole face of the ground; for the Lord God had not caused it to rain upon the earth, (because) and there was not a man to till the ground."—*Gen.*, *ii.*—*5*, *6*.

Pursuing this primeval hint, it would appear that the first condition of the earth was largely desert, from which there went up exhalations of moisture, under the sun's daily influence, throughout the day, which, by condensation at night, came down as dew.

The same phenomena precisely exist to-day on all great sandy or desert areas, viz: moisture in the form of mist, or dew, in an unvarying round from year to year.

It requires only the condensing surface of growing verdure; it may be of trees or shrubs or growing grain, over large areas; or, in short, just such a changed surface as man necessarily brings about as a tiller of the soil, to compel the moisture to take cloud forms in the atmosphere, instead of being dispersed by the daily radiation of solar heat. Everywhere, under these new conditions of husbandry, the clouds will gather into larger clouds, and overspread the heavens; and the impending shower will fall upon the farm and garden, not by a grace or fortuity, but by an eternal law. Yet, in this miracle of progress, the plow was the avant courier—the unerring prophet—the procuring cause. Not by any magic or enchantment, nor by incantations or offerings, but, instead, in the sweat of his face, toiling with his hands, man can persuade the heavens to yield their treasures of dew and rain upon the land he has chosen for a dwelling place. It is indeed a grand consent, or, rather, concert of forces—the human energy or toil, the vital seed and the polished rain-drop that never fails to fall in answer to the imploring power or prayer of labor.

On the contrary the Indians are, and, as far as we know, have always been, co-workers with the natural forces that maintain and extend desert conditions. He will neither plant nor sow, but by annual fires will destroy the occasional venture of forests and groves to extend beyond their reduced limits. He, by his law,

or economy of life, makes the desert still more a desert, and when the desolation is complete, he can either disappear as the exit of the non-fittest, or retreat to other wilds.

Thus it would appear that deserts and arid lands are not only temporary conditions of the earth's surface, but that, on the other hand, such unpromising areas can, by the industry and skill of man, be changed into fertile and productive fields.

To those who possess the divine faculty of hope—the optimists of our times—it will always be a source of pleasure to understand that the Creator never imposed a perpetual desert upon the earth, but, on the contrary, has so endowed it that man, by the plow, can transform it, in any country, into farm areas.

With the power in our own hands to make the wilderness and waste places glad, and to make even a desert blossom as a garden with roses, I cannot find suitable words of censure for those who falsely represent our great national domain as being in most respects not only arid and useless for the abode of man, but by a physical necessity forever forced to be under desert conditions that imply only the sustenance and support of a few nomadic herdsmen. That there should be a few who still retain the prejudices of a past generation on this subject, is surely no marvel; but that persons with the prestige of public position, and therefore supposed to be competent, on a special errand to ascertain the soil, capacity and prospects of our unoccupied territories should bring back such a report as recently made to Congress by the Public Land Commission, is consistent only with the too common practice of public fraud.

Prof. Aughey remarks that forests and cereal grains do not appear to have influenced rainfall as a procuring cause, but considers that they have doubtless secured the equal distribution of rains. The marked changes, however, which I am contending for, as having been effected by the westward progress of agriculture, have been gradual through a period of transition or conversion from uncultivated or wild to a cultivated region. The

sowing and planting of extended areas with the ordinary farm crops will supply a condensing surface in place of that which was comparatively dry, and therefore non-condensing.

It has been ordained that the growing period of all grains, including corn, shall present a uniform color of green which is best adapted to facilitate condensation.

In his recent work on the Physical Geography and Geology of Nebraska, Prof. Aughey has presented in a very able manner his theory of the cause of increase of moisture. He says:—

"Various reasons have been assigned to account for the increased rainfall of the State. Some have maintained that the cause is secular—that there are great periods when the moisture of a region increases for ages independent of any human agency, and that when it has reached a maximum it commences to decrease, which continues until it reaches a minimum. According to this theory, this region is now in a stage of increasing moisture. The advocates of this theory point out the fact that the Great Salt Lake in Utah, and lake Mono, lying at the eastern foot of the Sierras, are both undoubtedly rising. One of the objections to this theory is that the geological causes which produce increased rainfall are not now spontaneously operative. Western America passed through many such revolutions during the progress of the latter geological ages, and their causes are well understood. When, for example, the region of the plains was much lower than at present, and were dotted over with great fresh water lakes, a much moister climate than the present must have prevailed. The country between this and the Pacific is not now sinking—it is rather rising at the rate, according to Whitney, of a foot or two to the century. Denundation keeps it at about the same level. Unless, therefore, the cause is extra terrestrial we cannot ascribe the increasing rainfall to merely secular changes. There are no cosmical causes definitely known that would cause an increase of rainfall over an isolated region of the earth. That cause, therefore, as a producer of increased rainfall must also be dismissed.

"Another theory tenaciously held by some, is that the increased rainfall is produced by the iron on the railroad lines of the State and the wires of the telegraph lines. A few also believe that it is effected by the disturbance of the atmospheric circulatiou through the concussions of locomotives and moving trains. The objection to these views comes largely from the fact that in the older States where railroad lines are much more numerous and have existed much longer, no increase of rainfall has been noticed.

"A more plausible theory is, that the planting of trees has been the cause of increased rainfall. This, I admit, is a helping cause, but cannot be the main cause of increased rainfall. In Nebraska increase of rainfall commenced before the number of trees planted equaled the number destroyed. Comparatively few of the first settlers planted trees. Again, the statistics of forestry in the east, in Europe, in Asia, show that forests modify temperature, the violence of winds and equalize rainfall, but do not inerease it. While therefore it is admitted that the growth of forests exercise the happiest influences on climate, it is still evident that we must look elsewhere for the permanent causes of increasing rainfall. The same argument that applies to forests can be used in reply to those who insist that increased rainfall is due to the productions of corn and the cereal grains. It may be that the *continued and combined* action of these causes has some effect in increasing rainfall, but it must be small. There is, however, another cause, not heretofore mentioned, most potently acting to produce all the changes in rainfall that the facts indicated have taken place. Where then is that cause?

"It is the great increase in the absorptive power of the soil, wrought by cultivation, that has caused, and continued to cause, an increasing rainfall in the State."

"Any one who examines a piece of raw prairie closely must observe how compact it is. Every one who opens up a new farm, soon finds that it requires an extra force to break it. There

is nothing extraordinary about this. For vast ages the prairies have been pelted by the elements and trodden by millions of buffalo and other wild animals, until the naturally rich soil became as compact as a floor. When rain falls on a primitive soil of this character, the greater part runs off into the canyons, creeks and rivers, and is soon, through the Missouri, on its way to the Gulf. Observe now the change which cultivation makes. After the soil is broken, the rain as it falls is absorbed by the soil like a huge sponge. The soil gives this absorbed moisture slowly back to the atmosphere by evaporation. Thus year by year as cultivation of the soil is extended, more of the rain that falls is absorbed and retained to be given off by evaporation, or to produce springs. This, of course, must give increasing moisture and rainfall.

"In order to test the accuracy of this theory, which struck me as the only true explanation of this phenomenon as early as 1867, I, at various times, made some experiments. The first accurate experiments I made in May, 1872. I went east of the Antelope, about a mile from Lincoln, to a farm now owned by Mr. Hawley, after a heavy rain. With a rule six inches square was marked off of unbroken prairie, and this was taken up six inches deep and placed in a porcelain dish that had been previously weighed. The same amount, to the same depth, was taken from a cultivated field. The difference in weights between the two specimens was sufficiently great to prove that the cultivated land absorbed, at least during this rain, twelve times as much moisture as the uncultivated. The specimens were taken from lands only a few yards apart. After another rain, from near the same locality, a square foot three inches deep was lifted and compared with an equal amount from an adjoining field. The specimens were first weighed, then dried and then weighed again. The difference in this case indicated that ten times as much moisture had been absorbed by the cultivated ground as by the unbroken prairie. In June, 1873, similar experiments were made and with the same results. Where the rainfall is

slight, the difference will not be found to be so great. Much also depends on the lay of the land; care must also be taken that the cultivated land that is experimented with lies adjoining unbroken prairie, as there is often considerable difference in rainfall, especially in thunder storms, in the space of a quarter of a mile. In all cases the experiments were made immediately after or during the intermissions of rainfall. After only slight rains, the difference in absorptive power was only as four to one. The mean, however, of fifty of these experiments, gives an average absorptive power of cultivated ground over unbroken prairie of nine to one. To make allowance, however, for possible mistakes, I will make eight to one the basis of our future calculations on this subject.

"When the first settlements were commenced in Nebraska the rainfall of the State was not over twenty inches. Of these twenty inches probably not more than five inches soaked into the ground. Cultivated soil, however, absorbs nearly all the rain that falls. Where thirty-two inches of rain now falls in Nebraska on cultivated ground, not less than twenty-four inches are absorbed by the soil. Some of this is slowly given back into the atmosphere, and some of it goes to form the new springs of water that are making their appearance in so many places. Any one can see that this must make an enormous difference in the moisture of the atmosphere and rainfall. Before the settlement of the State, and before the consequent cultivation of the soil, what rain did fall, as already stated, soon left the State through creeks and rivers. Now the greater part of what does fall on all cultivated or broken ground, is retained by the soil, which becomes a reservoir of water to supply growing crops, and to give humidity to the atmosphere.

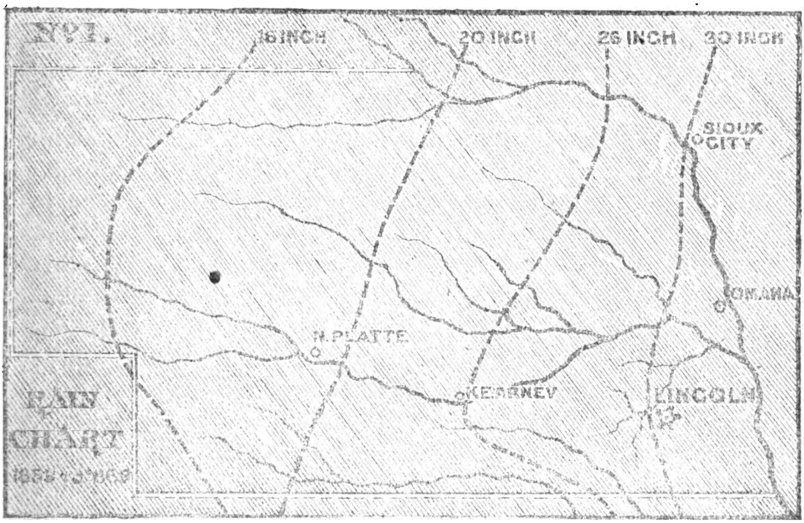
Absorptive Power of Nebraska Soil.

"No soil in the Eastern States has so great an absorptive power as the land in Nebraska. There, as a general rule, the underlying hard rock is soon reached, and during excessive rains

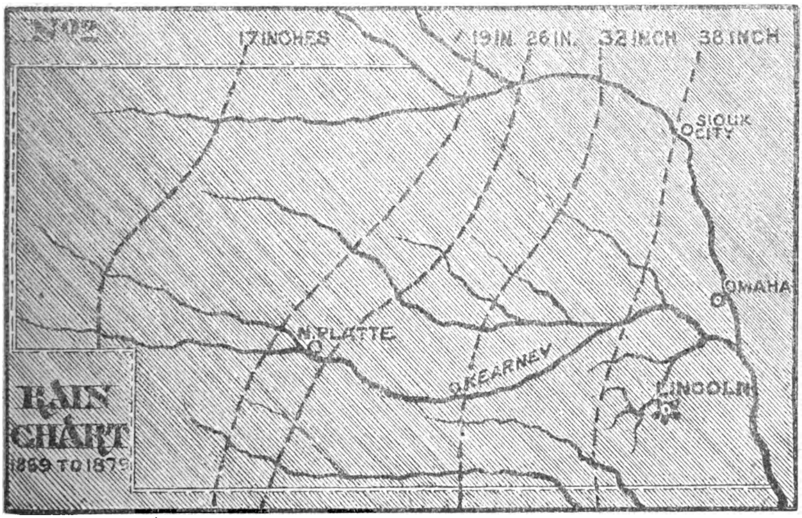
the thin soil is so supersaturated with water that excessive denudation of the soil is common. A thin soil also dries out, because there are no stores of moisture below from which it can draw supplies. Here, however, the superficial deposits are of very great thickness. The loess itself ranges from two feet to two hundred feet, and often where it is thin there are below it great bodies of drift. The average thickness of all the superficial deposits—loess and drift—is considerably over one hundred feet. This thickness, therefore, of surface materials constitutes the huge sponge that absorbs excesses of rainfall, and retains it to be given back to the atmosphere.

"Here, then, we have a cause competent to account for the increased rainfall of the State—a cause that not only has operated thus far, but is continuous. Through the operations of this cause the rainfall will become even more abundant than it has yet been, especially over the central and western portions of the State. The area of cultivation is extending rapidly each year, and continual encroachments are made on the lands in Western Nebraska that have been condemned as barren because of a deficiency of rainfall. Last year a large amount of land breaking was done near to and west of the 100th meridian in the Republican Valley and the table lands adjoining it. And it is a remarkable fact, that last winter (1879), there was an exceptionally large fall of snow, and this summer an abundant rainfall in the same region. In fact, this snow and rainfall extended all over Western Nebraska.

"The question is often asked whether the causes now producing the increased rainfall over the eastern two-thirds of the State will ever be sufficiently operative over the extreme western third as to make it an agricultural region. Of this I have no doubt. It probably will take a longer time to produce this change here than it did in Eastern Nebraska. The cause of this will be discussed presently. When the great body of the land near to and west of the 100th meridian is once cultivated that is capable of cultivation, the sufficiently and increasingly



ANNUAL AVERAGE RAINFALL FROM 1859 TO 1869.



ANNUAL AVERAGE RAINFALL FROM 1869 TO 1879.

moist region will encroach gradually on the dry region until it is entirely crowded out of the State."

The rain charts prepared by Prof. Aughey, showing the increase of rainfall for 20 years, (or two series of ten years each,) in Nebraska and Kansas, will put the reader, at a glance, in possession of the accumulated evidence upon this question. Prof. Aughey's explanatory remarks are also presented. The first chart gives the rainfall during the ten years ending November 30th, 1868. The second gives the average rainfall for the ten years ending November 30th, 1878. In constructing these charts I have availed myself of all the Smithsonian Reports, the Signal Office Reports, and my own observations of fifteen years. It will be seen that my results are very different from those hitherto obtained by an exclusive dependence on the Smithsonian Reports. By comparing these two maps it will be seen that there is a constant increase of rainfall in the State.

Chart No. 1.—This chart gives the areas where a certain average amount of rainfall occurred from 1859 to 1869. The rainfall during the years nearest to 1859 had less, and the years nearest to 1869 had more than that indicated on the chart. In other words, the amount of rainfall towards 1869 approximated already closely to that of the next period. These facts, however, cannot be exhibited on the diagram.

From the Missouri river, in Eastern Nebraska, to a line running across the State from north to south, from above Dakota City and near to Sioux City on the Iowa side, the average rainfall during these ten years was thirty inches. From this line to another that starts near the mouth of the Bow river, in Cedar county, and which runs a little west of south to near Kearney Junction, and then southeasterly to a point on the State line half way between the Blue and Republican rivers, the rainfall for the same time was twenty-six inches. The next line west of this starts a little above the mouth of the Niobrara, and crosses the State diagonally to a point a little east of North Platte. The space enclosed between this line and the preceding received

a rainfall during this period that averaged twenty inches. The next line west of the last starts about longitude 101°, runs southwest until 'it strikes the Niobrara, and then southerly until it reaches the south line of the State opposite Big Springs. An average yearly rainfall of sixteen inches fell here during this same period. West of this line the average rainfall was not determined, but it could not differ much from the preceding space.

Chart No. 2.—On this chart we have the mean annual rainfall between 1869 and 1879. Along the Missouri, as far west as to the line which starts near the mouth of the Big Sioux River, and crosses the State southerly and then southwesterly, and then a little east of south until it strikes the south line of the State where the Blue river emerges from it, over this space the mean annual rainfall during this period was 38 inches. Closer to the river the rainfall was much greater. Between this last line and the next which starts on the Missouri a little south of the mouth of the Bow river, runs diagonally in a curve until near Kearney, and then south to the south line of the State; this section thus bounded receives an average annual rainfall of 32 inches. West of this last line there is another which starts at the mouth of the Niobrara, curves southwesterly to a point a little west of Culbertson, on the Republican river. An average annual rainfall of 26 inches covers the space bounded by these lines. The next line west commences on the north line of the State at the mouth of the Keya Paha, runs southwest across the State, striking the south line half way between Culbertson and the meet line of the State. The space between this line and the last receives an average annual rainfall of 19 inches. Between this line and the next west, which starts a little east of the 101° meridian, runs in curve southwesterly to a point near Lodge Pole, on the Union Pacific Railway, and then south to the south line of the State. The space bounded by this and the last line receives an average annual rainfall of 17 inches. West of this line the rainfall is not definitely determined, but it probably does not differ materially from the preceding section. It should be remembered in exam-

ining these charts, that towards each line the amount of rainfall shades into the next division.

The questions involved in this discussion have been so ably presented in a recent paper read before the Topeka Scientific Club, by Mr. Holton, that it is inserted as a supplement to this chapter.

Remarks of Mr. Holton before the Topeka Scientific Club, March 31st, 1880:

Commencing at the Rocky Mountains and extending eastward almost to the Mississippi and the Missouri, and from the Gulf of Mexico to the northernmost part of the United States, lay the great American desert of 30 years ago.

How often do we see in the columns of the public press of to-day editorials, or letters descriptive of the trans-Missouri country, in which its vast resources and wonderful productions are glowingly portrayed; and, as if to correct an erroneous impression prevailing in the public mind, reference is usually made to the ignorance of the early geographers, who had included this fertile region within the bounds of the great desert—and yet the geographers of that day were right—for 30 years ago it was almost as much a desert 50 miles west of the Missouri river in Kansas and Nebraska, as it is to-day 300 miles west of the same point.

Travelers across the plains in those days, whether on the overland route to California or southwest on the Santa Fe trail, did not find the first two hundred miles west of the Missouri river what it is to-day, one vast meadow of rich prairie grass that covers alike the highest uplands and the most sheltered valleys, keeping the soil beneath cool and moistening the atmosphere, but instead they found the tall blue stem grass confined to small patches along the streams, and on the uplands or rolling prairie between the valleys, only the short, wiry buffalo and gramma grasses that afforded but little protection to the earth's surface. This surface by exposure to the sun's rays became heated, and by radiation soon communicated its own temperature to that of the surrounding atmosphere. Hence the hot winds that were the terror of travelers across the plains during the summer months in those days—winds of which the residents of to-day in the same localities have but little conception. It was the desert that gave birth to these winds, and only the desert can nourish them. The introduction of an element foreign to their nature was fatal to their existence, and so they have disappeared or been so far modified as to be lamb-like in comparison with their ancestors of a quarter of a century ago.

Thirty years ago no one could have attempted to open a farm on the uplands west of Topeka for the purpose of raising grain, fruit and vegetables, without having his sanity questioned; yet who to-day doubts its practicability, or where are the seasons more favorable to agriculture?

Farming in this vicinity was certainly attended with much uncertainty then, and for many years afterward; the climate and the seasons being as erratic and unreliable as it is to-day 300 miles further to the west.

The frontier of agricultural production twenty-five years ago, was placed on the 96th meridian, which runs north and south through the State about 18 miles west of Topeka, by a certain class of scientists who said: "Thus far shalt thou go and no farther." Ten years later, however, we find this fence taken up and removed to the 97th meridian, to be again taken up and put down on the 98th still five years later—and to-day we find philosophers of the same school positively asserting that agricultural production without irrigation is impossible west of the 98th, 99th or 100th meridian (as each one may have decided for himself) and that beyond these fixed lines increased rainfall or humidity, as a result of settlement, is an absurdity.

Some argue that the western limits of the Gulf of Mexico, being on the 98th meridian, all the south winds during the summer season west of that meridian in Kansas and Nebraska must blow from the dry region of Mexico across the desert plains, and consequently must be hot and free from moisture, bringing destruction to vegetation in its path, instead of relief.

Others again point, as an argument in favor of a fixed line between the moist and dry region, to the difference between the grasses on each side of this imaginary line—on the moist side the blue stem and other grasses and vegetation that find their natural element in a humid climate, on the west side only the grasses and vegetation adapted to an arid climate and capable of subsisting on a very limited amount of moisture. The fittest survive and the buffalo grass lives on the plains because moisture is too limited to give to the other grasses a foothold. This is true, but, as will be shown hereafter, it is a much stronger argument in favor of a movable than a fixed line.

Before meeting the arguments of these scientists of the Eli Perkins order, and before seeking the causes that have brought about the wonderful climatic changes that have taken place in this State in the last quarter of a century, it may be well to refer briefly to some of the fundamental principles and laws that govern the distribution of moisture over the great Mississippi basin.

To any one who will reflect upon the matter it will be obvious that the whole amount of rainfall over the whole earth is exactly equal to the

whole evaporation. If more water went up by evaporation than came down the waters of the earth would soon be dried up, and if more came down than went up the earth would soon be covered. Taking the whole earth the quantities are doubtless exactly equal. In most portions of the habitable globe, however, the rainfall is greater than the evaporation. If the evaporation was equal to the rainfall, if all the water that falls dried up from the place where it fell, there would be no water left to run off.

The rivers are the excess of the rain-fall and the quantity of water that flows out of the mouth of the Mississippi river, if measured, would be exactly the precipitation over evaporation in the whole Mississippi Valley. How then do we get this moisture back again that is being constantly drained off? The tropical sun evaporates it from the Gulf of Mexico. Clouds are formed and carried north on an upper-air current until about the 80th parallel of latitude is reached; they then descend and continue northward as a surface-current whose contact with the cooler surface of the earth, or cooler currents of air, condenses the vapor and precipitates it as rain; a portion of it evaporates from the ground where it falls and the rest is carried off to the sea to be again returned in rain-clouds.

The direction of the prevailing winds is an important factor in the distribution of moisture over the Mississippi Valley, and especially over the great Western plains. From April to September the prevailing direction of the winds is southerly. Along the centre of the Mississippi Valley the winds blow almost directly from the south; east of the Mississippi Valley, from the southwest towards the northeast, and west of the Mississippi Valley from the southeast towards the northwest.

According to Coffin's "Winds of the Globe," a standard authority, the winds leaving the Gulf of Mexico west of the Mississippi river, are deflected to the westward, following the Rio Grande as their western limit; as they proceed northward they gradually veer toward the east, and when the 40th parallel is reached blow as a southwest wind.

From October until March, the prevailing winds west of the Mississippi are from the north and northwest, but not so steadily as the summer winds from the south. The latter brings the rain in the summer season, but the former, blowing from a dry region, are generally free from moisture, and account for the comparative dryness of our winter months.

There are two sources from which our State derives its supply of moisture, which for the sake of convenience we will designate "foreign" and "local."

The foreign and principal source is the Gulf of Mexico, where, as already referred to, the waters of the gulf are evaporated, and rising above

the local influences of the sea are attracted northward as an upper-air current toward the lower barometer of the pole. As this moist air current passes northward through cooler climates its volume becomes gradually contracted, and with the contraction comes an increasing weight, slowly lowering it towards the earth, and finally touches it about the 30th parallel. From this point northward it becomes a surface current, and by contact with cooler air or other cooling influences the moisture is gradually condensed and precipitated until the polar regions are reached and the last vestige of humidity is forced out of it.

The "local" source of moisture is from local evaporation, and is valuable, not from the quantity of rainfall thus produced, but from its influence on precipitating the rain from the vapor-laden winds from the Gulf.

It is not my intention in this essay to prove by statistics, or from records of the Signal Service Bureau, the climatic changes that have taken place in the last twenty-five years, but to take only such proofs as nature itself affords.

The climatic conditions existing in the vicinity of Topeka, and just west of the Missouri river 30 years ago, have already been briefly alluded to. Buffalo and gramma grasses, now found only west of the centre of the State, then covered the uplands almost to the Missouri river. The blue-stem and other taller varieties of grass were to be found only along the streams, because only there was sufficient moisture to maintain their existence.

From old settlers who located here twenty-five years ago we learn that owing to the scant covering of vegetation the prairie sod was tough, sun-baked, hard and dry; that it was almost impervious to rain and shed it as though the whole ground had been covered over with asphalt; that the frequent prairie fires only increased the sun-baking process, and that in consequence the radiation of heat from the exposed surface of the earth made the summer winds during the daytime more hot than comfortable.

We also learn from the same source that the manner in which the rains were precipitated while similar in some respects to the present, yet on the whole were very different. Then, especially during the summer season, nearly all the precipitation took place after sundown and in violent thunder-showers. Rainy days such as we now enjoy were then unknown during the growing season, and hot winds, now unknown, were then frequent.

The reasons for this violence of the thunder storms and the absence during the summer months of general rains, were these:

Radiation of heat from the exposed prairie warmed the atmosphere nearest the earth's surface. With the increase in temperature the air

became expanded and set in motion towards a region of lower barometer, where its equilibrium could again be re established. Other currents of air rushing in to fill the vacuum thus created, were in turn heated, and so a surface current was established during the heat of the day forming a barrier between the moist air current passing over from the south and the parched earth beneath. The moisture in the upper current could not be precipitated because the warm air in the surface current was, by contact, constantly increasing the temperature of the atmosphere above it, and by consequent expansion removing it farther from the point of saturation.

Under these circumstances precipitation was possible only through the medium of electricity. When the sun had disappeared below the horizon and radiation for a time had ceased, the lower strata of air became rapidly cooled. The equilibrium of the atmosphere was disturbed as well as its electrical condition. To re-establish this, electrical communication between the clouds and the earth became a necessity. Rapid condensation and precipitation followed, with the usual accompaniment of thunder and lightning, and frequently with a violence that is rarely witnessed in these days.

But with the advent of the industrious settler came a change. The tough, impervious sod was broken and the land cultivated. When the rain fell, instead of running off as formerly, it was received into the cultivated land and held for evaporation. Trees were planted and ranker vegetation commenced to cover the ground. Humidity and evaporation were no longer confined to the narrow limits of streams, but spread where cultivated fields were found. A gradual increase in the humidity of the atmosphere took place, and the blue stem rapidly spread over the uplands, driving out shorter and weaker grasses and completely covering and shading the earth's surface, keeping it cool and stopping entirely the radiation. Even the prairie sod when shaded by the taller varieties of grasses and penetrated by their roots became mellow and porous, admitting into the soil the rai that was formerly surface-drained.

All these agencies of taller grasses, cultivated fields, growing crops, trees and ranker vegetation have contributed to the general amelioration of the climate by retaining the rain that fell on the soil, by stopping radiation and allowing the moist air currents to come in contact with the earth, by acting as condensers of the moist air brought in contact with their cooling influence; by affording greater attraction to the electricity in the atmosphere and by local evaporation, increasing the atmospheric humidity. The result is that each year the rains are becoming more general and better distributed over the settled portion of Kansas, and the

seasons more equable. Condensation takes place at a lower elevation, or nearer the earth's surface, hence precipitation is not so rapid, the rain-drops are not so large and the soil has more time to drink in the rain that falls, and preserve it for future use.

Farming from 1855 to 1865 was attended with vicissitudes that were unknown to the farmers from 1870 to 1880.

Very few sections in the United States have been more favored in the past ten years than the eastern half of Kansas, and yet in the ten years from 1855 to 1865 the failures were many, and gave to the State the reputation for being a land of drouth.

As we follow the tide of emigration we find the blue-stem grass has always been close in the wake of this human tide. Twenty years ago we found it so far west as Emporia and Junction City, and four years later as far as Marion Centre and Abilene. Ten years ago there was no blue stem grass in Harvey and Salina counties, except along the streams, the uplands being completely covered with buffalo grass. To-day buffalo grass cannot be found in either of these counties, unless it be an insignificant patch here and there, and the bottoms and uplands are alike covered with blue stem. Pushing west to the centre of the State, we find Rice and Ellsworth counties have almost succumbed to the blue stem, and Barton and Russell, still further west, are now being taken possession of. In fact the blue stem is increasing rapidly in all the counties between the 98th and the 100th meridian, and it is only a question of time when they too will be covered, although the progression westward necessarily be slower as higher elevations are reached.

The finest hay and pasture lands in Central Kansas to-day are to be found in the sand hills, along the Little Arkansas river, that ten years ago were bare and almost destitute of vegetation. The sand hills south of the Arkansas river in Barton, Pawnee and Edwards counties are becoming grass-covered, and the same change is going on in Northwestern Nebraska.

The streams of Kansas afford as strong proof of the climatic changes effected by settlement and cultivation of the soil as do the grasses. Prior to settlement, an ordinary thunder shower on the plains filled all the water courses over which it passed, banks full, in a very short time after precipitation commenced, and a few hours after it had ceased to rain the streams would resume almost their normal condition. The flow of the water in the streams was without regularity or permanence. The percentage of the shower retained in the soil was so small, and the accumulation in the water courses so great, that often these volumes of water carried surprise and even destruction with them to points far below, where no evidences of a shower existed.

This spasmodic rush of great volumes of water is no longer to be seen in our streams within the limits of agricultural settlements.

Last fall it was my privilege to note how great was the change. There are several parallel streams in Harvey county that ten years ago were swollen suddenly by thunder showers in the way I have just described. Then the upland prairies were covered with buffalo grass. Now none but the blue stem and other tall grasses are to be found. Then not an acre was cultivated, now one third of the country is under cultivation. Then the streams referred to were bank full in a very short time after it had ceased to rain. In October last it rained steadily for nearly 24 hours, and yet it was even 12 hours before the water in the streams commenced to rise. The increase was gradual and a good volume of water was maintained for 48 hours after the precipitation had ceased. The cultivated soil and suns-haded prairie for a time absorbed the rain almost as fast as it fell, and acting like a brake, held it back among the roots of the grass and in the soil, to feed out the surplus more gradually to the water courses, thus giving to these a uniform volume, such as was not known of them prior to settlement. Owing to this reception of the rain into the soil instead of being shed off, many water courses that were formerly dry a portion of the season are now permanent running streams, and many springs have commenced flowing that before settlement had no existence.

But I think we have still a much stronger proof of the increase in humidity and moisture as a result of settlements, in the productions of our State. Who believed, even ten years ago, that the heaviest wheat productions of our State would be west of the 97th meridian, and who then believed that Indian corn could be successfully raised in Sedgwick county, which now ranks fourth in the State in the production of this crop. Eight years ago the officers at fort Larned were firm in their convictions that neither grain or vegetables could be raised at that distance west. All their efforts at raising garden vegetables had failed, even with the aid of soldiers to water them. Yet within four years, when the tide of emigration had reached the Pawnee Valley, crops of all kinds were raised with fair success, and from that time (1874) to 1878, the wheat crop was above the average of the State, while that of 1879 was almost a failure.

Notwithstanding the overwhelming evidence that nature furnishes us of an increase in the rain supply of Kansas, meteorological statistics do not show a corresponding, or even a material increase in the rainfall, and the records of man and those of nature seem to be in conflict.

Admitting, for the sake of argument, that the actual number of inches

of rainfall is no greater now than it was ten or twenty years ago, those who offer this as proof that no climatic changes have been effected overlook one very important factor, which is, that the amount of rain that falls is valuable to us just in the proportion that we utilize it. If the annual rainfall at Topeka 25 years ago was 25 inches it is safe to say that less than ten inches of this quantity was retained in the soil and utilized, while fifteen inches was carried off in the water-courses and wasted. Now if we, by cultivation of the soil and other means already referred to, utilize 20 inches out of the 25 that falls during the year, we double the amount of rainfall for all practical purposes over that of twenty-five years ago, although the actual quantity falling was exactly the same. The average rainfall of Kansas as far west as the 100th meridian for the past ten years is sufficient for the agricultural wants of our State, if we could but utilize it all, and the question at issue should not be, "Will the rainfall increase?" but instead, "Can we utilize the rainfall we are now receiving?"

But notwithstanding the fact that the meterological observations taken at the U. S. forts show but a slight increase in rainfall between the time prior to and that subsequent to settlement, I still firmly believe that the increase of rainfall in actual inches has been considerable, for the following reason:

Where the best conducting medium exists, there the electric current will establish readiest communication with the earth; hence, before any settlements reached the plains, the magnetic storms naturally followed the streams as presenting the most attraction for the electricity in the air.

When the railroad was first built across these plains it was noticed that summer storms, traveling apparently across the railroad track, would, on approaching it, be turned from their course, and, instead of crossing, follow the direction of the track, the strong attraction afforded by the iron rails and telegraph wires, and the ground broken in construction of the road, being sufficient to hold them to the line for a considerable distance. With the general breaking up of the prairie sod and cultivation of the land, a new circuit was established for the electricity in the atmosphere as attractive as that in the valleys, and consequently more equable distribution of the rainfall all over the country has been the result. This is one reason why comparisons of statistics of rainfall taken at the different posts on the plains during the past twenty years are so unreliable as a basis of comparison. Nearly all these posts were located at a point on some of the principal streams that presented the most advantages for water, grasses and timber. From the time these posts were occupied up to the advent of settlers, magnetic showers found great

attraction to follow the valleys, and little to attract a general distribution on the upland; hence the records of ten, fifteen and twenty years ago of these posts show simply the rainfall of the most favored localities. A comparison of the rainfall of the valleys, prior and subsequent to settlement will show but a small increase as compared with what the uplands would show had we any previous record of the rainfall on them. This being unfortunately wanting, we have no means of determining by figures what the real increase has been.

Another important factor in increasing the rainfall has been the prevention of general prairie fires by the opening up of farms. Any one who has driven in a hot summer day over a prairie country where part had been recently burned over, can realize what difference there is in the temperature between the portion burned and that on which vegetation still remained. If all the grass and all the crops and vegetation were burned off and kept burned off between this point and the south line of the State during this summer, the rainfall of Shawnee county would be reduced at least one-third, and the temperature increased to an extent that would remind some of our oldest settlers of their early experiences in Kansas. The great prairie fires that prevailed over western Kansas during the fall of 1878 and spring of 1879, were undoubtedly contributing causes to the drouth that prevailed on our frontier last season. Had there been no prairie fires for three years previous to 1879, the season of 1879, on the plains, would, I am satisfied, have been far different, for even the buffalo grass if permitted to grow three years without burning will fairly shade the ground.

In Pawnee county, in September last, during the driest weather, I saw fields in which the buffalo and gramma grasses had been preserved for four years, and these so completely shaded the soil that it was mellow and moist, while on the surrounding prairies recently burned over it was hard, dry and water-proof.

Agriculture is the principal resource of this State. Every interest in the State, commercial, mechanical or political, is dependent on the productions of the soil. Times are with us good and bad just in proportion as our crops are good or bad. The possibilities of crop failures here do not lie in the soil itself, as its great fertility is unquestioned, but in the climate. Every farmer, every business man and every citizen watches with closest interest the signs of the weather on which so great results depend. The subject of meteorology and climatic changes is therefore fraught with interest to our young commonwealth, and one which I think in the past has not received the attention it merits. Kansas is as yet but in the infancy of her development.

A large portion of her territory as yet lies beyond the pale of civilization. A part is on debatable ground, where a struggle is now going on between man and the elements, while the greatest portion has already been rescued from the desert and now has no superior on the continent as an agricultural region.

It is therefore pertinent, I think, for us to devote a few moments to the question of a continuance in the future of the climatic changes of the past, and how far west agricultural production is possible without irrigation, or if there is any limit. Will the rainfall be permanent as far west as the 100th meridian? and if so is there any possibility of its extension west of that line? The fact that almost all the moisture precipitated as far west as the 100th meridian comes from south and southeast winds, is I think proof that the gulf winds extend that distance west in our State, and I find from examination of the record of seven years' observation at Fort Larned prior to settlement, that the number of times which the winds blew from the south and southeast was very much greater than from the southwest. With south and southeast winds moisture is possible as far as the 100th meridian; with southwest winds it is impossible, because the latter blow over a dry, sandy region that robs them of all their moisture. It is evident, then, that the further west of the 100th meridian we go the more we are dependent on southeast winds for the necessary moisture, and the amount must be proportionately lessened, unless the snow on the mountain ranges has some influence in increasing the rain supply, as many claim. Whether the fact that years in which the mountains receive the heaviest fall of snow, being also the years in which rainfall in Western Kansas is greatest, are simply coincidents, or founded on some law of nature I cannot say, not having given the subject any attention, but it is certainly one worthy of investigation. If the mountain snows do not affect the rain supply of the plains, owing to the higher elevation, the more rarified atmosphere and the dependence on south winds, the climatic changes and increase of moisture west of the 100th meridian must necessarily be slower than it has been east of that point. Still I believe that time will work a great change in the climate of the plains clear to the mountains. In fact a great change has already occurred in the climate of Eastern Colorado. Dry farming—*i. e.* farming without irrigation, has in the past few years become occasionally possible, whereas 25 years ago, or prior to any settlement, such a thing was impossible. Those who have visited the mountains during the summer have no doubt noticed the storms gathering in them and starting eastward over the plains as if they would deluge the whole country, and yet they had scarcely left their mountain home before they had disappeared

and the sky was once more clear. Why? Because the radiation of heat from the plains coming in contact with the mountain cloud, expanded and dissolved it so it was no longer visible. Were the plains covered with vegetation so as to prevent this radiation and offer greater attraction to the electricity in the clouds, many of these showers would be precipitated that are now driven away. A nearer approach of the settlements to the mountains, a more complete network of railroads and irrigating canals, may not make the plains a general farming country, but they will certainly modify its present aridity and make possible the production of such crops as are adapted to a dry climate.

While the rainfall of Western Kansas may be materially increased, the rule will always hold good, that as we go westward the quantity of the rainfall will be lessened, but this discrepancy between the precipitation of Eastern and Western Kansas is equalized by the greater capacity of the soil of the latter to absorb and retain moisture where cultivated or shaded. I know of no soil that possesses this quality to the same extent as the soil of our great western plains. These begin properly where the limestone formation ends, in Butler, Marion and Dickinson counties, and extend westward to the mountains. The surface soil is a sandy loam, varying in depth from one to ten feet, with a porous substratum, giving it perfect natural drainage. When the rain falls on this soil it is rapidly drained through the surface soil far below into the subsoil, where it is largely retained for future use. The surface soil will not cake or get hard, owing to the perfection of its drainage, but always remain mellow and loose, and the heat of the sun cannot penetrate more than an inch below the surface and as the moisture is supplied by capillary attraction from the reservoir below, so long as this subterranean supply lasts the roots of the plants will find water.

In the eastern third of our State, the surface soil drains naturally and almost as rapidly as the plains to the west; but the subsoil being less porous and often clayish, its capacity for absorbing and retaining heavy falls of rain is very much diminished as compared with Western Kansas. It wastes more and requires to be oftener renewed.

The topography of the great plains is also more favorable to the retention of the rainfall, the surface being generally more level and the divides not so high and rolling, so that when the rain falls the smallest percentage is surface-drained. Owing to this peculiarity of the soil of Western Kansas, as good farming results can be obtained on a measured rainfall of 16 inches, during the growing months of the year as can be obtained rom 21 inches in the same time in eastern counties with a clay subsoil.

The history of the first ten years of settlement between the 97th and

98th meridians presents no such failure of crops, and drouths and difficulties as had to be endured by the settlers east of the 97th meridian, in the first ten years of their history, yet the condition of both sections at the time of settlement were about the same. The greater success attending the first settlement of the central portion of our State I have accounted for in this way: First—the absorption and retentive qualities of the soil referred to; second—the more favored topography; and third—its more rapid settlement, more people having located in the central portion in the year 1878 than in the eastern portion in any four years of its early history. As the herd law of our western counties is credited with having contributed largely to the rapid increase in cultivated acres of that portion of the State, it has also been an indirect cause of the rapid change effected in the climate, and is entitled to credit to this extent.

What Western Kansas now needs is a more general distribution of its rainfall, and this can be accomplished by protecting the prairie grasses from fire—by cultivation of the soil, by tree planting and by the spread of the taller grasses over the uncultivated area. This, together with westward march of immigration in compact settlements, making improvements as they go, will accomplish the climatic change desired even to the west line of the State. The trouble of late years has been that our frontier settlers have rushed west too fast; that they have scattered too much instead of sticking together, and by their united efforts accomplishing what was so much needed. Nearly 50 miles of frontier were occupied by settlers in 1878; but not until all this territory is occupied by a denser settlement can the climate be sensibly affected. As the change of climate west from the 98th meridian will be slower than east of it, there is important need that the tide of emigration should march forward slowly but compactly, and not push out in detached settlements. Unfortunately the class who insist upon being our pioneers are the ones that can least afford to wait until the country is changed from a grazing to an agricultural one, and hence great suffering must ensue, especially in an unusually dry season like 1879. Our cattle and sheep raisers should be our pioneers, men who will combine stock-raising with farming.

I do not claim that this progression westward is annually continuous. Excessively dry and wet seasons are a part of the history of every State and every country. For fair and satisfactory evidence we must take the average of a succession of years, and not the most favorable or unfavorable ones.

To those who have not given this subject serious thought it may at first seem that such changes as have been effected in this State by civilization

are greatly exaggerated, but when you come to think of it, there would be a violation of some well known law of nature if settlement of the country did not produce these results that I have attempted to relate. For instance, there cannot be evaporation where there is no water in some form or other, and there cannot be humidity in the air when there is no evaporation, and where there is no humidity there will be deficient rainfall, as the slower the evaporation and the more humid the air, the greater will be the precipitation.

Nothing is wasted. The climate and vegetation of the plants prior to settlement were best adapted to the wants of life then on them. When man came with his intelligence, industry and perseverance, conforming to nature's laws, the wilderness yielded up its barrenness and conformed itself to his wants. It was only by the united efforts of a great tide of industrious men and women that this great change could be wrought To straggle off in detached bands, remote from each other, would do no good. They must go forward as a compact mass, and in this battle with the wilderness it is the vanguard that must do the hardest fighting, and clear the way for those who bring up the rear.

As civilized man moves westward step by step, possessing the lands conquered from the elements, the red man recedes farther and farther into the wilderness, and as the red man and the buffalo recede before civilized man, so the grass of the buffalo and uncivilized life recedes before the vegetation of civilization.

The little study I have given this subject impresses me with the greatness of the field of investigation that lies before us in this direction. What I have presented is the record of nature, but nature's record should be supplemented by systematic and well-distributed observations on the part of man.

It would be interesting to know, for instance, how much difference there is between the relative humidity of the atmosphere at a given point where buffalo grass now covers the ground, and the same after the blue stem grass had taken possession. To what extent radiation was reduced by this change—whether there was a more general distribution of the rainfall over a given surface?

What the increase, if any, between the rainfall on the uplands removed from streams, prior to and subsequent to settlement and change of vegetation? Whether the velocity of the winds is reduced by the increase of humidity? Whether the snow in mountains has any influence on the rainfall on the plains? Whether the nature of the soil has anything to do with encouraging precipitation or retarding it? These are but a few of the things that require careful and systematic observation in order to understand accurately the climatology and meteorology of our State.

CHAPTER VI.

THE WATER RESOURCES OF NEBRASKA.

Naturally Allied to the Topics Considered in the Two Preceding Chapters are the Permanent Sources of Water for the Common and Extraordinary Demands of Both Agricultural and Domestic Use—We Shall Consider, 1st, The Atmospheric Reservoir; 2nd, The Average Yearly Precipitation; 3d, The Water Contained in Cultivated Soils; 4th, The Source of Common Wells; 5th, Artesian Water.

A SOIL perfectly dry, is inert, or dead. It may have the choicest ingredients, and be adapted to the great classes of grains, grasses and fruits. The chemist will pronounce the analyses unrivalled in valuable qualities; yet an absence or deficiency of moisture renders it a failure in every respect. Water is therefore the *sine qua non* of any soil, and, more than any other, its indispensable element and condition.

Its presence, in quantity greater or less; its supply or source; whether temporary or permanent; its increase, if deficient, and the practical modes by which it may be obtained or its quantity increased—these are questions of paramount importance, and have on this account an exalted place in these deliberations.

Water is now called a fluid mineral; as oxygen united with a metallic base—not yet discovered, but whose gas form is hydrogen. On this account, therefore, it would appear that this subject—sources of water and its relations to agriculture—comes properly within the province of geology and mineralogy.

The first and most abundant source of water is the atmosphere, which is a vast fluid sea, enveloping the earth with a depth of 45 to 50 miles. It has a capacity for moisture, either in a visible or invisible form. The amount contained, *en masse*, may not be determined; but, for a mile in depth of the lower stratum or cloud-bearing portion, it has been ascertained to con-

tain, in a column one mile high, with a base of one yard, at a temperature of 75° F., 55 lbs. of water, and half this amount or 27½ lbs. at 42° F.

Over every acre, therefore, we have for every mile in height 266,200 lbs, or 133 tons of water at 75°, or one-half this amount at 42°. The amount of moisture suspended over a section of land, is by the same estimate 85,120 tons. The amount of moisture contained in the air in any given locality, will, of course, vary not only with the temperature, but also with the surroundings—as proximity to the sea or mountains, or areas wooded or unwooded; bare sandy or rocky surface; amount of previous cultivation, etc., etc.

To determine these, and other causes of changes in regard to moisture, is the proper province of meteorology, which from uncertain elements is, at present, very incomplete. The amount of water contained in the first two miles' depth, or lower stratum of air, is an average quantity for the season of average temperature, hence the rainfall is the surplus which is relinquished by lack of capacity. The two amounts, therefore, 1st, of moisture in the air, and 2d, of rainfall—may be considered independently of each other.

We are able to recognize in the atmosphere the medium of transfer of water between the sea and land; but, as yet, feebly comprehend the machinery by which it is done. The clouds and the mist are both mysterious. We can evaporate water, make steam or vapor, but we cannot make a cloud, or even approximate it. By a subtlety, all its own, it eludes us, and leaves us to suppose that it is controlled by electric agencies. Until we know these elements, the science of meteorology, as an exact science, will be like the play of Hamlet with Hamlet left out.

It should be understood that this estimate represents for the summer and winter seasons an average amount, which is of course subject to variation under extraordinary conditions. A long term of dryness would sensibly reduce the amount usually in store. The spring of 1880 indicated unusual scarcity of moist-

ure over great areas, requiring for rainsa long continuance of winds from the direction of a more humid atmosphere. When once this has taken place, evaporation will aid the still increasing humidity, and the usual round of rainy days will set in. We know of no prophetic wisdom or insight that can in the least assist us. The adage, that "all signs fail in dry weather," is based upon the law just referred to. The conditions for renewing precipitation are dependent on such elements that one who would be wise, as a weather prophet will make the fewest prognostications. And whatever may be assumed as a cause, such as the inferior or superior conjunction of planets, or any relative position of them from which wet, dry or stormy weather can be foretold, may be safely set down a cheap and easy practice upon human credulity.

Secondly, we will next consider the rainfall or precipitation as a stratum of water upon the earth, when it is measured in inches before it has disappeared, either by watersheds, drains, ravines, rivulets, creeks, runs, or by absorption into the soil. The rate per cent. per annum, we find, constantly varies.

The average amount of rain for Nebraska is 27 inches; this gives for every square foot of base a column 2¼ feet high, or (2¼ x 62½) 151½ lbs. of water; and for every square yard, 1,364⅔ lbs. Hence upon every acre of land, the amount yearly precipitated is 663,502⅔ lbs.

Next, or third in order, is the average amount of water stored in depths of soil, within reach of grass and grain roots, which may also be regarded as a constant quantity, but, in no manner connected with either of the former sources of moisture. Instead of passing away, either by evaporation or drainage, it has been absorbed and remains a fixed fact; liable, however, to increase to the point of saturation, or plenum, or to diminish to a minimum amount.

Certain experiments, made with both the top soil, or humus, and the subsoil, or loess, give the following results:

The average amount of water in the soil of a well-cultivated Nebraska farm for a depth of eight feet may be taken, at an av-

erage for the season, as equal to a column of water one-fourth of the same depth, or two feet in depth of water. This estimate will apply to farms that have been open long enough by deep plowing to receive a saturation of rainfall, requiring from five to seven years. This amount of water—allowing only 20 inches for its depth—suspended in the fine soil and subsoil by capillary attraction—a term that proves our ignorance, but represents the fact—is equal to $62\frac{1}{2} \times 1\frac{2}{3}$, or $103\frac{3}{4}$ lbs. of water for each square foot of surface, and $933\frac{3}{4}$ lbs. per square yard, and for each acre nearly 240 tons.

I found this average amount of water in fields of growing grain on the 100th meridian in Furnas county, in July, 1878—near Lyndon P. O.

Fourth, the well stratum: We will next estimate the amount of water stored, or kept at greater depth in the earth, and inaccessible by the common well.

It is almost invariably found in a stratum of sand, at a depth nearly uniform below the surface; showing that the water-bearing stratum of sand has a very extensive range throughout the West. Nearly all wells draw their supply from it; and so regular and constant is its place, that the altitude of any given place furnishes the estimate for the depth of the well.

We will put this water-bearing sand at 40 feet in thickness—including both strata of coarse and fine sand. Of a column, taken at random, one-fourth to one-third is water, giving 12 feet of water in one stratum, which is limitless as far as we know. This affords, for every foot at a depth from 20 to 200 feet from the surface, the following amount: 12 cubic feet of water $\times 62\frac{1}{2}$, 750 lbs.; or under every square yard of surface, $3\frac{1}{3}$ tons of water within convenient distance, and the farmer can draw constantly, with every appliance, and never sensibly diminish the supply..

These subterraneous sands were, doubtless, ages ago worn down by glacial agencies from the eastern spurs and parallels of the Rocky range, and by the same means moved and distrib-

uted over the vast area, whose probable eastern limit is the synclinal of the Missouri river, and extending north and south, in distance corresponding to the Rocky Mountains, which must have been in that era far higher and more precipitous than we find them now.

Passing by the proofs written in the inconceivable billion of grain particles of this wide spread substratum of sand, of the great antiquity of the first division of the glacial epoch, it is proper to note this valuable fact, viz.: that these filtering sands, silex, feldspar, and in general disintegrated granites, afford the purest water.

Steadily and slowly finding their way eastward by percolation, protected on all sides except from local intrusions, setting itself free in myriads of springs, or head streams of river systems, and being constantly reinforced by the rains and melting snows, this enormous incline of subterranean water bears onward as a moving sea, silent and unseen, yet restrained and kept in store by the purifying sands, just deep enough not to interfere with the husbandman, yet easily within reach in everlasting abundance. At a trifling cost the idle wind becomes the farmer's willing servant to bring these waters, clear as crystal, and distribute them to any part of the house or farm.

Fifth, Artesian water: Lowest, but not less in comparative importance, is a stratum of water which, in a few instances, on being reached by test wells and borings, yields an abundant flow of artesian water, and naturally excites the question, "Can we confidently expect artesian water over large areas in Nebraska?" In recording my vote in the affirmative, it is proper to give a few of the physical reasons, based not merely upon what has been achieved, but upon the position of the sub-earth rocky strata of the State, upon which the flow of artesian water depends.

Let us examine first the remarkable artesian well in the government square, at Lincoln:

This well is 986 feet in depth; five inches in diameter at the bottom. It was put down in 1872, under the direction of John Eaton, chief engineer.

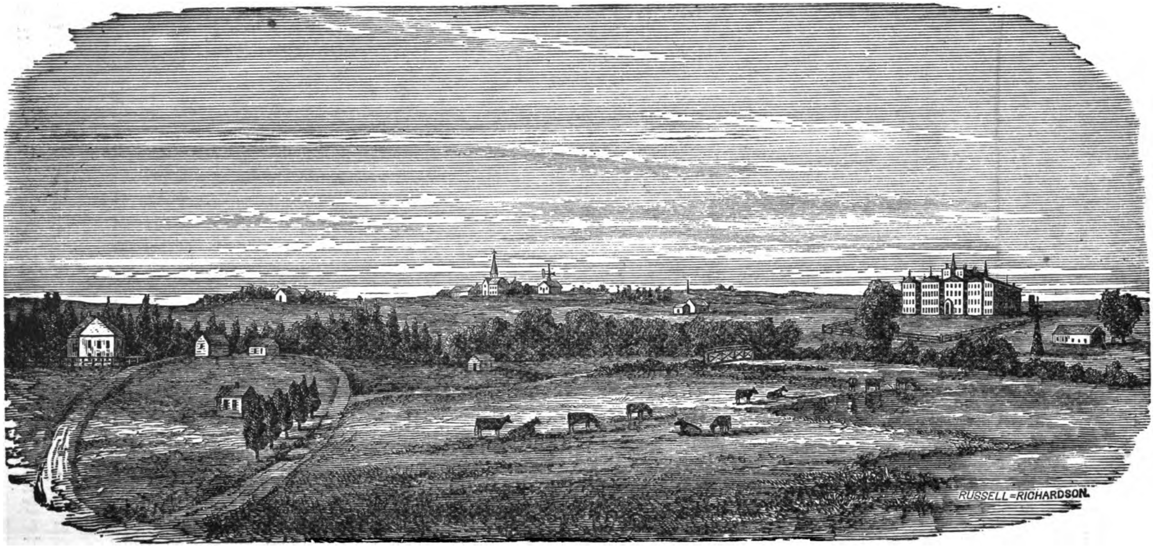


Plate No. 4.—Salt Creek Valley, Lincoln, Neb.

The order and thickness of strata are as follows:

0.—4 feet black loam.
4.—36 feet dry, fine yellow sand.
40 to 96.—56 feet coarse sand, with layers of clay.
99.—3 feet water lime, cap rock, coarse gravel over rock.
104.—5 feet fine gravel, with clear, soft water.
107.—3 feet red sand stone.
108.—1 foot yellow sand stone.
117.—8 feet conglomerate rock.
119.—2 feet brown sand stone, with yellow clay.
139.—20 feet light brown sand stone, very fine and clear, (drive pipe 122 feet.)
140.—1 foot water gravel.
150.—10 feet light sand stone.
153.—3 feet water gravel.
159.—6 feet light brown sand stone, with iron pebbles.
171.—12 feet red sand stone, lime-coated pebbles; salt water.
200.—24 feet brown sand stone and red marl clay.
221.—21 feet very salt water; about 50 degrees in strength, sand and clay, blue and red marl, lime pebbles.
250.—29 feet same as above, changes slight.
255.—5 feet blue clay.
256.—1 foot of crystalized lime stone, (six inch casing rests here.)
267.—11 feet lime stone very soft and shaly.
315.—48 feet soap stone.
370.—55 feet soap stone, streaks of lime and shale.
373.—3 feet lime and sulphate of iron and black slate.
400.—27 feet red marl, soft and muddy.
434.—34 feet soap stone.
436.—2 feet lime stone.
451—15 feet black slate.
506.—55 feet lime stone.
528.—22 feet red sand stone, with marl seams, very soft.
545.—17 feet soft and tough marl, of various colors.
555.—10 feet hard crystal lime stone, struck water here.
Water.—5 inch casing rests here.
616.—61 feet magnesian lime stone with pebbles.
620.—4 feet very black slate.
627.—7 feet lime stone close and hard.
635.—8 feet red marl, packed on tools.
652.—17 feet lime stone.

695.—43 feet marl.
706.—11 feet lime stone, very hard.
718.—12 feet red marl.
736.—18 feet crystal.
813.—77 feet lime stone, with streaks of slate alternating.
833.—20 feet black and red streaks, one to two feet in lime rock.
839.—6 feet black slate.
883.—44 feet lime stone, with seams of slate, light blue and gray.
903.—20 feet lime stone, very hard and white.
909.—6 feet coal and slate.
986.—77 feet lime stone rock, alternated with layers of slate. The color a bright blue and some streaks of green, mixed with small shells.

At a depth of 184 feet from the surface, salt water was reached. It appeared to come from a heavy stratum, 71 feet in thickness, of brown-colored rock, and to carry dissolved salt in quantity. As the middle of this stratum was reached, the brine was strongest, and had reached the point of saturation. This sand-rock stratum is, doubtless, the reservoir whence all our salines derive their waters. It may contain strata of rock or crystalized salt, as in Louisiana, or Poland, but it is more probable that the great sand stratum is thoroughly permeated with strong brine, as in Saginaw or Onondaga, and that the amount or supply is dependent on the lateral extent of this sand rock. There is no doubt but it underlies a large area, judged by the fact that the Beatrice well, 50 miles south, is also saline. Besides, the constant outpouring does not appear to perceptibly diminish the amount or strength of the brine. After passing through the salt-bearing stratum, the ordinary succession of limestone, shales, slates, sand, rock, etc., is found to a depth of 560 feet, where a stratum of coarse and fine sand, with pebbles, is reached, through which passes a current, or mass of water, with great force. So strong is this current that it rendered the waters magnetic, doubtless, by friction. The iron bars of the drills were highly charged, and kept their polarity for a long time. The incline of this water stratum was southeast, partaking of the grand incline of general topography.

The water stratum at 560 feet, of sand 15 feet, and magnesian limestone, with beds of coarser sand and pebbles—in all 61 feet —as minutely described by Mr. Eaton, is the source of artesian water at Lincoln. As soon as intersected its upward force was very great. It hurled a spouting column of water into the air with a force of 18 atmospheres. It maintained itself in column of 30 feet by a continuous pipe, and appears to have power sufficient to supply with uniform flow its present quantity of salt water, which is estimated at one barrel per minute, or 20,000,000 gallons per year.

From a careful study of this remarkable artesian well, it is evident that salt water reaches only a depth of 256 feet, and is inclosed within the salt-rock stratum, 71 feet thick.

When first struck by Mr. Eaton the brine was very strong, and equal in saltness to the waters of Saginaw, or Onondaga. This water rose in the well to a distance of nearly 30 feet from the top, whence it could be pumped into vats for solar evaporation.

The artesian water proper, from the water, sand and pebble-stratum, is pure water; but at 256 feet mingles with strong brine, and at the surface has become greatly reduced in strength. Hence, in order to have a flow of pure artesian water, shut off the salt water by the usual casing process, with packing or seed-bags, and at a trifling cost Lincoln can have a perennial fountain of pure water that would soon be recognized as of great value.

The artesian well at Lincoln is the second of its kind in the vicinity; the first having been constructed in 1870, near the salt marsh. The facts concerning it are similar to those already described, proving the abundance of salt water of great strength and purity at the same relative depth, and also the great force of upward pressure, which can be explained only upon the theory of water levels. The amount of water from this well is less now than formerly; not, however, from any lack of supply, but rather from want of care. Both of them, if well-tubed,—an in-

dispensable condition—will yield over 40,000,000 gallons annually.

By locating several of these wells—one at the Capital, one at the University, another at the Prison, and a fourth at the Asylum—each with an eight-inch pipe, and, taking care to shut off the salt water, the city of Lincoln would easily and cheaply dispose of the water-supply question, and at the same time render the aspiring Capital of Nebraska far more attractive than could be done by any amount of money expended in architecture.

Taking the amount of water from a five-inch tube at 20,000,000 gallons annually, an eight-inch tube will afford nearly 60,000,000 gallons annually.

If, on the other hand, only salt-wells are wanted, they could be located within one-half a mile of each other, near the railroad tracks, and each well owned and operated by a company; or individuals could, by a long lease on most favorable terms profitably compete with Eastern manufactories of salt. The dry atmosphere of Nebraska, and the extraordinary number of clear days, indicate that solar evaporation will be more rapid here than Michigan or New York.

The third deep well, reaching these strata of artesian water, is at Beatrice. It was first designed merely as a test for coal. Its depth is 1,200 feet. It is located on the heights, near the Court House. The water rose within six feet of the surface, showing that if the well had been put down near the river it would have been a flowing, or artesian well. Its waters are slightly saline, indicating the gradual disappearance of the great subterraneous salt-bearing stratum in a southwesterly direction.

The fourth well, which has reached a corresponding depth, was put down at Omaha, iu 1878. Its depth is 750 feet. The flow is continuous.

Omaha is 250 feet lower in altitude than Lincoln, and Beatrice nearly 200 feet above. The depths of these wells—750, 1,000 and 1,200 feet, respectively—indicate the artesian water-supply to be on the same general level with regard to each other.

We may, therefore, consider the artesian water-stratum in Nebraska as reliable for artesian wells in the eastern part of the State, and also available in the centres of the great valleys running east and west.

The artesian wells of Aurora, Joliet, Wilmington, Ottawa and Chicago, in the State of Illinois, are supplied wholly from St. Peter's sandstone, at a depth varying from 500 to 1,200 feet. These wells which are uniformly successful, are drilled through the upper and lower silurian series, and are continuous in solid rock, until the great sandstone water-stratum is reached.

This water-stratum is variously estimated from 200 to 500 feet in thickness, and has an inclination, or dip, to the south and east. It is underlaid with calciferous sandstone—a very hard stratum—continuous for great areas and impervious to water.

The silurian rocks above are also firm and compact, so that the water-bearing rock, or St. Peter's sandstone, is as firmly encased as if protected by iron pipes to the sources of water, distant to the northwest 300 to 500 miles. The amount of water thus constantly pressing its way downward beneath the superincumbent strata toward the south is beyond computation. It does not appear to diminish by the constant drainage of a dozen artesian wells located in the same town, as in Joliet and Chicago.

In Aurora an artesian well, 700 feet deep, supplies the C. B. & Q. Ry. car shops and locomotives. It is so pure as to contain only four grains per thousand of foreign matter. It can, with very strong tubing, be made to rise 30 feet above the surface. Its value in railway economy is inestimable.

At Joliet, artesian water supplies the State penitentiary, affording, from a five-inch tube, an abundance for all prison uses, steam, bath, washing, etc., leaving nineteen-twentieths of the supply unused. In the city, an artesian well supplies the hydrants as well as many houses. The united stream, of perhaps a dozen wells, forms a fair mill stream, which escapes by a rapid channel to the river.

By putting these wells down with an eight-inch tube, instead of five, the capacity is nearly three times as great. With reservoirs, upon the heights of any of the valley towns, it is easy to see that not only could they be cheaply and permanently supplied with the purest water, but that mills could also be furnished with water power.

It occasionally happens that the artesian well is cut in proximity to water currents holding iron and sulphur in solution, but for the most part they are exceptionally pure.

There appears to be no limit to the number of artesian wells that can, in this manner, be put down in Northeastern Illinois at all points below the level of the great supplies of water, along the exposure of St. Peter's sandstone.

Referring to the source of artesian water in Nebraska, we find it in the Lincoln well at a depth of 556 feet. It rushes up as if impelled with very great force, "equal" says Mr. Eaton, "to 18 atmospheres per square inch;" and this flow continues unabated. Yet there is danger, from the easy disintegration of some of the strata passed through, of the current becoming partly, or wholly obstructed. But, when these wells are carefully cased, or tubed, there is no reason why they will not, for years, keep an undiminished flow.

The deep sand strata underlying Lincoln, Beatrice and Omaha, from which the artesian water is supplied, is not local but general. It does not appear of uniform thickness, but has divisions, or strata separated by intercallations of slate, or clay, or limestone, or sandstone, which, for a considerable area, may separate these sand, or water strata; but, beyond these temporary separations, they again unite like the branches or bayous of a surface stream.

Suppose this deep stratum, or system of sand, at a depth of 500 to 900 feet,—itself having a thickness of 50 feet more or less—and having at the same time an inclination, or dip, of six to eight feet, thus partaking of the average parallelism of geological formations, and being also well protected above and below by

strata more firm and solid, it will be easy to see that the same results must follow in Nebraska as in Illinois, under similar circumstances.

A water-bearing stratum of sand or sandstone, with a rise of seven feet per mile, will, in bearing west 150 miles, give the same hydraulic pressure as a standing tube of at least 1,000 feet. Now, knowing that the gradual rise of all strata toward the west and north is at least seven feet per mile for over 400 miles, it appears quite certain that this vast source of water can sustain any draft made upon it by artesian wells. It is also evident, that the head, or source, has sufficient elevation to force water in tubes to any desired height above the surface.

In short, the theory of artesian wells, as applied to Nebraska, does not appear to lack any elements of success. Nor can any argue against its application in any part of the State, especially in the lower portions of large valleys.

It will appear, perhaps, marvelous to many not familiar with the distribution of water in the earth, that such a vast quantity of it should actually exist. It is, doubtless, of the same average quantity for any of the States and Territories east of the Rocky mountains. And while the common or well stratum of water reached by every farmer, for home and farm use, is near the surface, this, or the artesian stratum, does not, as far as yet known, exceed 1,000 feet; a depth reached easily and with trifling cost by town, precinct, county or other public aid that may be very properly voted for such a decided public improvement as artesian water.

While our estimate of the subterranean artesian water may be beyond our power to comprehend it, yet the great fact will slowly and surely take possession of us, as a people, with most cheerful results, considering that the deep water-stratum is the continuous accompaniment of the so-called American Desert —a name that has now happily passed away forever.

Estimated at 100 feet in average depth, this stratum is equivalent to one-third its depth of water, or 33 feet; and this is, doubtless,

continuous throughout the entire Eastern slope of the Rocky range, extending as far east as the synclinal of the Missouri river. It is in effect a subterranean sea, yet so solid and moveless that the superimposed strata are as permanent as if resting upon granite.

But, whatever its mass or quantity may be, it has been slowly, by the seasons' successive changes through a series of not only years but of glacial epochs, rainfall, ice and snow continually coming from the same source, and by absorption disappearing into the earth's unseen depths, silently pressing its way eastward and downward by its own weight, until it has crowded this vast store-house to its utmost capacity.

The foregoing principles and facts apply generally to the entire area east of the Rocky range, between, and including Texas and Dakota. The Mountain region, of 1,200 miles in width by nearly 2,000 in length from north to south, is also equally well-supplied with subterranean water. Many hundred experiments both for common and artesian wells attest both the abundance and purity of water at all depths. In this view of the present and future water supply, for nearly every portion of the immense domain belonging to the United States, it is, indeed, difficult to see any reason for the excessive haste with which the Public Land Commissioners are urging forward a bill in the present Congress to condemn 500,000,000 acres of land as "non irrigable" and, therefore, non farming land. Nearly all of these lands are underlaid with inexhaustible strata, or supplies of water, which, by the cheapest contrivance, can be brought to the surface in unlimited quantities.

The land bill referred to, and now being considered, proposes to abolish the present laws of homestead, pre-emption, timber and soldiers' entry by quarter-section, which adds every year to our population 100,000 farmers with new farms and homes, and in place of said laws substitute a law permitting tracts of land to be entered, containing, each, four square miles, or 2,560 acres. By the proposed law 4,000 herdsmen will control and own

500,000,000 acres in the heart of the American Republic. By the present law of homesteads, under which the great Northwest is rapidly developing into a mighty empire, we shall have 4,000,000 more farmers than we now have. The choice lies between 4,000 rich cattle kings, or feudal lords, and 4,000,000 independent farmers. And yet the plotters and abettors of this stupendous robbery assume, in their fraudulent evidence, that the country they thus intend to devote to barbarism has no water resources.

A letter from Fort Worth, Texas, recently written by a Chicago *Tribune* reporter, states:

As there has been so much said and written about the many

ARTESIAN WELLS

in this city, I feel that I have failed in my duty if I do not describe these wonderful wells. There are 21 now in this city, 14 of which are flowing from 100 to 1,500 barrels of water per day,—which is conveyed to all parts of the city in water-tanks and wagons, and delivered at ten cents per barrel to customers. One peculiarity about this water, it neither stagnates nor becomes insipid, even in the warmest weather, but retains its purity no matter how long it may be left standing, so thoroughly is it filtered through the pure white sand that not an impurity remains. It washes even better than rain-water, if possible, and leaves the skin soft and clear. It opens the pores, and lets off impurities in the system through their natural channels, so that typhoid, to-day, has ceased to exist among those who constantly use the water. Many of the old ailments and complaints common to the people here have, in a measure, disappeared; and this artesian water is unanimously recommended by the "medicine men" who have analyzed it, as a restorative of the enfeebled and sick to health. The temperature of this water is 71 degrees Fahr., and is not affected by the extremes of heat or cold where it flows from the wells. Our winter cistern and best well water is from 65 to 68 degrees.

THE DISCOVERY OF THESE WELLS,

which are now of inestimable value to this country, was purely accidental. Mr. L. H. Cresswell, on his farm nine miles southeast of Fort Worth, in 1875, dug a well 44 feet deep, and, not finding water, was determined to ascertain how deep he should have to go before he could get a supply; and, to the astonishment of all, he went to the depth of 454 feet, where he found a bountiful supply of the pu-

rest, sparkling water, slightly impregnated with sulphur. This well attracted much attention throughout the country; but the great cost (about $1,000) was more than most of them were able to pay; and, at the same time, there were doubts as to the flow of water. No one else attempted it, although Mr. James Peters, the pioneer well-driller of this country, insisted that water would flow in this city, and at less depth than Mr. Cresswell's well. Being poor himself, he was unable to make the experiment alone upon his correct theories of the water-bearing strata from which the flows would rise. But, by a firm reliance in this theory and his characteristic energy, at his own house in the southwest part of the city for nearly two years, as means and opportunities offered, he drilled his own well, which finally sent out a flow of 150 or 200 barrels a day of pure, filtered water, many feet above the surface. This was in August, 1878, and the depth of the well is about 280 feet. This work of Mr. Peters inspired confidence, and since then to the present time there have been 21 of these wells dug, and which are now flowing constantly, the flow varying from 200 to 1,500 barrels per day.

THE THEORY

of water here is, that the white sandstone in which the water exists outcrops in counties north cf here, and that it dips to the east and southeast. This stone is very porous, and the water striking on the country where this sand outcrops, is conveyed by these with the dip of the sandstone, under the upper surface of a late formation which is our lime and shell formation, as if this sand were at some former period the bed of some sea or ocean, and the blue sand just above the white sand is sediment settled on this sand. The shell rock, which is a bed of about ten or 12 feet in thickness, which covers all this blue sand, has been found in all the wells, lies just over the blue sand, and from there to the surface are continuous layers of limestone rocks; and, when the orifice is made through this 250 feet upper formation, the pressure of the water from the fountain-head rises above the surface. The reason that some do not flow with as much pressure or force is because the elevations of these points are higher and nearer the fountain-head. There is said to be another water-bearing stratum to the northwest of this one, that underlies one stratum of water sandstone, which will not likely be over 400 or 500 feet under the outcrop of this one.

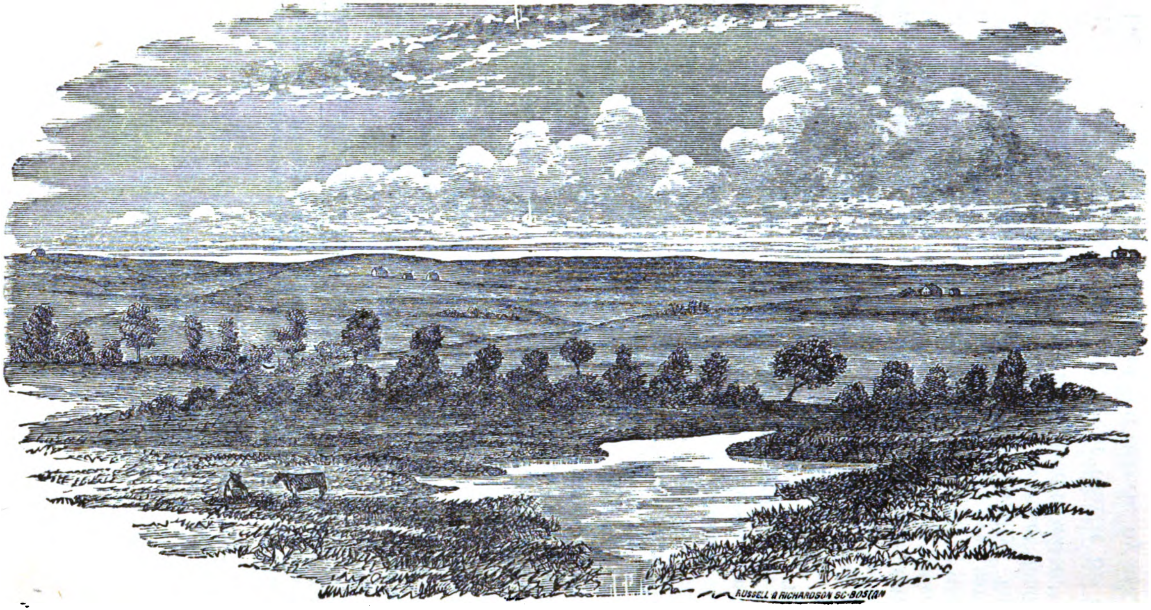


Plate No. 5.—PRAIRIE VIEW NEAR SUTTON, NEB., CLAY CO.

CHAPTER VII.

ORIGIN OF THE PRAIRIES.

The Prairie System of Nebraska and Kansas—Comparative Views of Lesquereux, Whitney and Caton—The Relation of Grass to Trees and Shrubs—Present and Ancient Floras—The Science of Forestry—Tree Culture in the Northwestern States.

IN a recent number of the *North American Review* occurs a graphic description of the Western prairies, in which the able writer gives to the prairie system of Nebraska and Kansas pre-eminence for both beauty and fertility. He says:—

"The most perfect display of the prairies is found in the eastern half of Kansas and Nebraska. It is no exaggeration to pronounce this region, as left by the hand of Nature, the most beautiful country in its landscape upon the face of the earth. Here the forest is restricted to narrow fringes along the rivers and streams, the courses of which are thus defined as far as the eye can reach, whilst all between is a broad expanse of meadow lands, carpeted with the richest verdure and wearing the appearance of artistically-graded lawns. They are familiarly called the rolling prairies, because the land rises and falls in gentle swells, which attain an elevation of thirty feet, more or less, and then descend again to the original level within the distance of one or more miles. The crest-lines of these motionless waves of land intersect each other at every conceivable angle, the effect of which is to bring into view the most extended landscape, and to show the dark, green foliage of the forest trees skirting the streams in pleasing contrast with the light green of the prairie grass. In their spring covering of vegetation these prairies wear the semblance of an old and once highly cultivated country, from the soil of which every inequality of surface, every stone and every bush has been carefully removed, and the surface rolled down to absolute uniformity. The marvel is suggested, how Nature could have kept these verdant fields in such luxuriance after man had apparently abandoned them to waste."

Yet, however enchanted the intelligent tourist or traveler may be, he will end his ideal revel and reverie by asking the

unfailing, omnipresent question, viz.:—"What is the origin of the prairies."

From observation on the smaller lakes and lakelets in Minnesota, Michigan, Indiana and Ohio, Prof. Leo Lesquereux saw, as he thought, the outline of a theory which would account for the present prairie system.

After a brief view of the soils of these dry lakes, and the tree growths on the margin, he says:—From these facts, no other conclusion can be taken than this:—that all the prairies of the Mississippi Valley have been formed by the slow process of sheets of water of various extent, first transformed into swamps, and by and by drained and dried. The high and rolling prairies, the prairies around the lakes, those of the bottoms along the rivers are all the result of the same cause, and form a whole and indivisible system."

But since lake bottoms are genarally level, or present a general concavity of surface, and since prairies afford every variety of topography of rolls, hills, slopes, plains, divides, inclines, draws, ravines, terraces, bottoms, etc., it seemed quite difficult at the outset to meet these formidable difficulties. But the heroic Lesquereux sweeps them all away with a pen stroke.

"I believe" says he, "that though undulated the surface of the prairies may be now, as it has been originally horizontal enough to form shallow lakes, and then swamps like those which now cover some parts along the shores of Lake Erie, Lake Michigan, etc. I have followed for whole days the sloughs of the prairies, and have seen them constantly passing lower, and well-marked channels, or to the beds of rivers by the most tortuous circuits, in a manner comparable to the meanderings of some creeks in nearly horizontal valleys. Indeed, the only difference is that in the high prairies there is not a definite bed, but a series of beds extending, narrowing, winding in many ways. This explanation seems so natural that I could not understand how high prairies could be perfectly horizontal."

No person ever appeared more charmed with his favorite

idea than the bold Lesquereux with his pet theory for the origin of the prairies.

"The level of the low prairies being scarcely above that of the lakes, their surface after an overflow becomes dry by percolation and evaporation, rather than by true drainage. But wherever the rivers have cut deeper channels, the drainage has constantly taken place towards those deep channels, and the water, though its movements may be very slow, furrows the surface in its tortuous meanderings, and from this results that irregular, wavy conformation, generally and appropriately called rolling prairie."

For illustration of his theory Prof. Lesquereux refers to the prairie soil of Illinois:—

"Its thickness is first to be considered; it varies from one to four feet, and even more. How has been produced this enormous coating of black mould which covers the clay subsoil? and, also, how has this subsoil been produced, if not under the influence and action of water?. Complete oxidation of vegetable remains has never resulted in the keeping of such a peculiar thick compound as is the soil of the prairies. We must then consider this prairie soil as formed under peculiar chemical action by a slow oxidation or decomposition of vegetable matter, retarded in its action by water, in preventing the free access of oxygen, as in formation of peat. This (prairie) soil then, as we have said, is half peat and half humus."

Prof. Whitney, formerly State geologist of California, writing of the formation of prairies, considers the absence of trees caused by the fineness of the soil, and partly by the accumulation in the bottoms of immense lakes of a sediment of almost impalpable fineness under certain conditions.

"Judge Caton, of Illinois, observes:—

"That the prairies have been formed under water, except the very limited portion of the surface which has been added from decomposed animal matter since their emergence, will not be questioned by any one of the least observation; but that is not the main question involved in

Plate 6.—VALLEY OF THE BIG BLUE RIVER, SEWARD COUNTY, NEBRASKA.

the present inquiry. Why are they not covered with forests? It is the cause of this feature which Prof. Lesquereux undertakes to explain. His theory of the terrestrial formation is introduced solely for the purpose of explaining this phenomenon, and which it fails to explain.

If the Grand Prairie of Illinois was formed under water, from which it emerged by a slow process of elevation, or by a subsidence of the waters, a theory to which I am prepared to assent, or if it was formed piecemeal by having one section of shallow water and then another cut off from the main body by the accumulation of deposits by the agitated waters, as described in the theory under consideration, then the lands now covered by the immense forests lying north and east of us, in Wisconsin, Michigan, Indiana, and Ohio, and of the same general altitude, were formed in the same way; and if this process of formation is the true cause why trees are not found on our prairies, then the same cause should have produced the same effect there. But more, if this theory be correct, then the latest formations of land should be nearest the great bodies of water from which they have been detached, and less congenial to the growth of trees, and we should expect to find the forests most remote from the waters. Now, the very reverse of this is found in fact to be the case. At one single point alone does the Grand Prairie abut on Lake Michigan, and that for the short distance of four miles south of the mouth of the Chicago river. The great forests of Indiana are in the north part of that State. and we must go south of those forests to find her large and luxuriant prairies. In Northwestern Indiana we find those large swamps, which may have been cut off from the waters of the lakes in the manner supposed by Prof. Lesquereux, and which are now in the process of being filled up; but it is a remarkable and interesting fact, that, wherever a point, no matter how small, in any of these great marshes has been raised above high water, it is covered with trees. No traveler can pass over the Pittsburg, Fort Wayne & Chicago railroad, for instance, without having his attention arrested by the innumerable islands, all covered with trees, rising out of this great marsh, all with surfaces but a very few feet above water. If he has passed down the St. Lawrence, among the Thousand Islands, he is at once reminded of the fact by the similarity of the relative location, size, and number of the islands. I have in vain sought among these marshes for a dry place devoid of trees, except on the dykes themselves, portions of which may be found quite destitute of any vegetation, where the dry sand will afford sustenance to none."

The one gross fault with these theories is, that they are hasty and indiscriminate, when a larger view would include all that

these theorists have stated, without shutting us up to narrow requirements. We can take in all that Prof. Lesquereux says, viz:—that the great prairie system has been covered with water, and at the same time understood that water action is not, or was not even the remotest cause of the unwooded districts. The prairies may come after the existence and subsidence of lakes, but they come simply in the order of events, and not as a consequence of water. There is nothing in the water or primitive lake theory that does not apply equally to the wooded regions of any country.

Referring to Lesquereux's theory, and Whitney's, Prof. Winchell says:—"The fatal objection to this theory, and all the theories which look to the physical, or chemical condition of the soil for an explanation of the treeless character of the prairies, is discovered in the fact, that trees will grow when once introduced."

In the reign of one of the Georges, a scientific commission was sent down to plymouth to ascertain the cause of the sands in the harbor.

A white-haired veteran, like Thackeray's wiseacre, who "wore specs and had a weakness for geology," thus explained the difficulty:—addressing the royal commission—"You see, my royal sirs, I am the oldest man in the colony. When I first came here, eighty years ago, there was no sand in the harbor, and Tenterden steeple was not built. But now there are sands in the harbor; and so, my lords, I think Tenterden steeple is the cause of sands in the harbor."

The numerous lakes of Minnesota, Iowa, Wisconsin and Michigan are mostly shallow, covering often areas 5 miles by 10 or 15. They have a dark sediment bottom, generally upon clay, which being impervious like leather, will for ages maintain these bodies of fresh water as they are. In some cases of higher altitude, with smaller lakes, the clay can be punctured, and after the escape of water the black sediment becomes good soil. Or the lake may be drained by cutting down its lower edge with a deep ditch. It is obvious that the concave-shaped clay substra-

tum caused the lake, and it appears that the fresh water acted as a medium through which the sediments, no matter how obtained, were precipitated; but directly the lake is drained the soil is ready to raise crops of grains, grasses or trees—but it does not become a prairie. West of the Missouri River, and, as far as known, west of the Mississippi River, in Nebraska and Kansas, the brown-colored top soil is not a sediment of, but instead, the same material as the sub-soil, whether loess or drift, having the same chemical elements, but colored by successive years of decay of grasses. Whether these grasses, year after year, were burned or disappeared by the slower process of oxidation, they were certain to contribute both the dark or humus color, besides a certain amount of material not being sediment in any sense. We are agreeably relieved from introducing the needless miracle of innumerable lakes as prairie antecedents.

The evidence of prairie origin deduced from the disappearance of lakes, large or small, is therefore rejected as not sufficient. The lake patches with subsequent drainage, are simply facts by themselves, but not in any way related to the origin of the vast unwooded regions of North America.

Judge Caton further remarks:

"Who that is intimately acquainted with and has carefully studied the prairies will dispute that the soil of the groves has been formed by the same process that has formed the soil of the treeless prairies? The theory that these groves mark out the places where the agitated waters have thrown up embankments, which cut off the shallow waters where the naked prairies have been formed, is not sustained by either the topography or the geography of the ground. If this theory were true we should find the groves in continuous lines, upon elevated ridges composed of sand and gravel, such as we uniformly find to compose those dykes which undoubtedly have been formed, as supposed, and have performed the office assigned them. Such, however, is not the case. In very few instances do we find the groves occupying continuous, unbroken ridges of any considerable extent. We find them scattered over the prairies without law or order, excepting only the condition of water in some form in their vicinity, which may serve to protect them from the conflagration of the prairies. This water need not charge the soil itself with humidity in

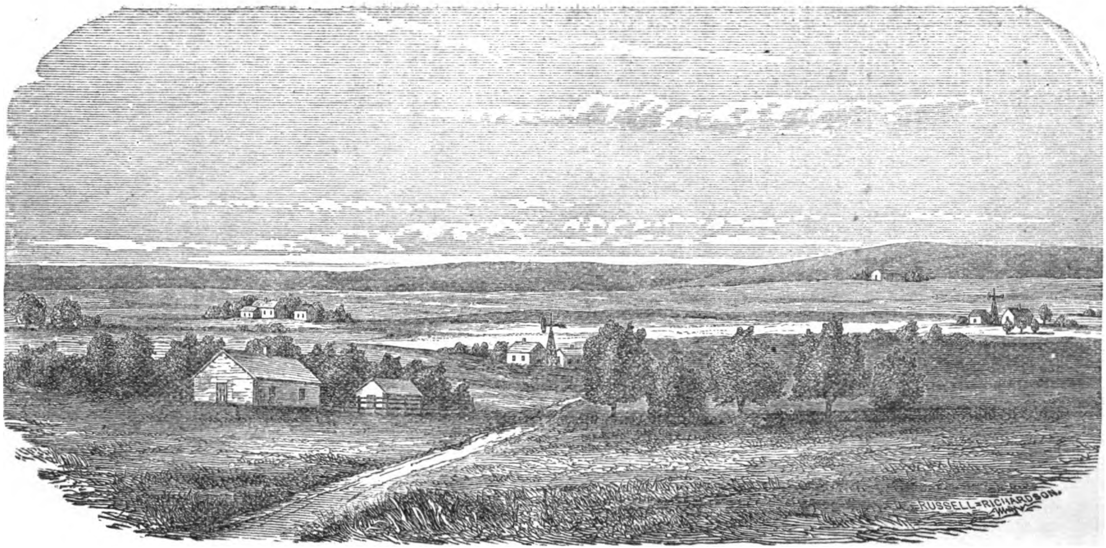


Plate 7.—PRAIRIE, GROVE AND RIVER, GAGE COUNTY, NEBRASKA.

order to secure the growth of trees, for it is not uncommon to find the groves occupying the highest and dryest knolls; but at their feet, or at least so near as to serve as a protection, water is sure to be found. In former times, when the traveler in crossing the great wild prairies saw a grove in the distance, he shaped his course to it with the absolute certainty of finding water there, no matter how dry or parched the prairie might be.

The soil, too, gives no evidence of an accumulation of material such as is usually thrown up by agitated waters. When we penetrate the soil of the woodlands, even to great depths, as in digging wells, and the like, we find the same formations which are met with in surrounding prairies. I have already alluded to the fact that whenever we find a chain of groves occupying the high divides of the water sheds of the prairies, they are generally separated by deep depressions which would have destroyed them as dykes for the separation of the waters.

As I have already stated, I am prepared to admit, as almost a demonstrated fact, that not only our great prairies, but also our great forest lands and the desert plains, filling all the space between the Alleghanies and the Rocky mountains, were originally formed or deposited under water, from which they have emerged by some process of nature, probably very slow; but this elevation has not been dependent, to any considerable degree, upon additional deposits, but upon the actual upheaval of the mass of matter originally submerged, or the subsidence of the waters by the removal of barriers which once restrained them."

The proportion of prairie to forest is so great in the Western States and Territories as to reverse the order of the inquiry. It seems here more proper to enquire, why have we woodland and grove and densely timbered tracts in the Canadas and Eastern States, instead of these "unshorn fields, sublime and beautiful, for which the speech of England has no name?"

This leads to another inquiry, viz: Which is the normal condition of the surface; which has priority, prairie or woods? Are not prairies, and pampas, and steppes, and vast unwooded areas quite as natural as forest-covered plains and hills? Have we not a problem quite as intricate in explaining the existence and permanence of forests as in presenting a theory which explains their absence.

Individual estimates of the comparative value of wooded and

prairie regions would vary as to the tastes or traditions of men; but the general summary of an impartial census leaves no room for debate on the superior advantages of prairie surfaces. The center of empire makes its way westward over these natural meadows more rapidly than through dense forests. The unprecedented advance in the United States since the year 1840, in political power, wealth and population, is due mainly to the prairie system of the western and northwestern States and Territories. The landed estate of Illinois is worth $1,000,009,000 in forty years, is equal to that of Ohio in nearly eighty years, and an average prairie county in the interior of Nebraska in twelve years attains the wealth and population of one in the woods of Ohio, of equal size, with seventy-five years of toil. After searching all that is known upon the subject, we may see that both prairie and forest are natural conditions, and that it is in the power of man to make or unmake, to have either surface, or to combine the two in any manner suited to his use or caprice. It does not matter, therefore, whether grassy plains or boundless forests have priority as the primitive condition. It would easily appear from both geologic and human history that the two orders of surface have alternately held possession, and that the present prairie and timber areas, wholly or in part, were once covered with forests, and vice versa. So that whenever we raise the question of priority we are at once carried into the realm of geologic history, whose faint outline can be seen on the shores of the old Silurian sea, where the first frouds of vegetable life raised their tiny forms, suited to the earliest condition of light, air and moisture consistent with life upon the planet. But the two great orders of vegetable life, viz: Trees and grasses, are so diverse in mode of growth, in form and in degree of vital force that we may naturally look in the direction of this diversity for causes that shall logically lead us toward a satisfactory explanation.

The superior vital force of grass growths, aided by favorable conditions, enables them to exclude timber growths, except

where protected by natural barriers. The constant and free action of these relative forces maintains the present boundary between prairie and timber areas. Whenever these forces are inconstant, or irregular, or suspended by human agencies, the relative areas of each are varied or changed.

Grass is called "an annual" plant, yet in an enlarged sense it is perennial. There is more vitality in the rhizome or roots of grass than in the oak or palm. Whatever may destroy a tree or shrub brings no harm to grass. An ocean of flame may sweep over the prairie and consume every living thing, and leave the plain a parched and desolate waste, yet in a month the grass is green over the entire area, but the trees are dead. What required ten, twenty or a hundred years to accumulate as forest or grove, can be replaced only by the same number of years, while grass will come to its best estate in the summer time of every year. I offer this primal and fundamental relation between grasses and trees, as the present and procuring cause in a theory to explain, philosophically, the origin of the prairies:

"Next in importance to the Divine profusion of water, light and air, those three great physical facts which render existence possible, may be reckoned the universal benificence of grass. Exaggerated by tropical heats and vapors to the gigantic cane congested with its sacharine secretion, or dwarfed by polar rigors to the fibrous hair of northern solitudes, embracing between these extremes the maize with its resolute pennons, the rice plant of southern swamps, the wheat, rye, barley, oats and other cereals, no less than the humbler verdure of the hill-side, pasture and prairie in the temperate zone, grass is the most widely distributed of all vegetable beings, and is at once the type of our life and the emblem of our mortality. Lying in the sunshine among the buttercups and dandelions of May, scarcely higher in intelligence than the minute tenants of that mimic wilderness, our earliest recollections are of grass; and when the fitful fever is ended, and the foolish wrangle of the market and forum is closed, grass heals over the scar which our descent into the bosom of the earth has made, and becomes the blanket of the dead."

"Grass is the forgiveness of nature—her constant benediction. Fields trampled with battle, saturated with blood, torn with the ruts of cannon, grow green again with grass, and carnage is forgotten. Streets abandoned by trafic become grass-grown like rural lanes, and are obliterated.

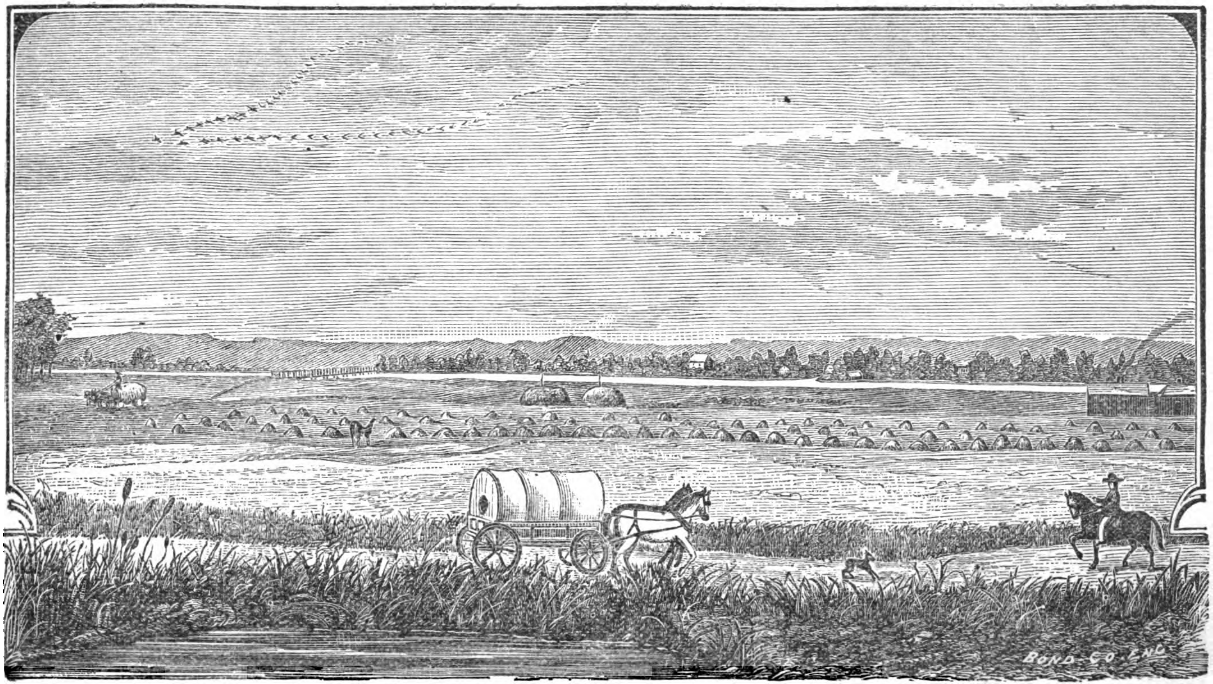


Plate 8.—PLATTE RIVER AND PRAIRIE, MERRICK COUNTY, NEBRASKA.

Forests decay, harvests perish, flowers vanish, but grass is immortal. Beleagured by the sullen hosts of winter, it withdraws into the impregnable fortress of its subterranean vitality, and emerges upon the first solicitation of spring. Sown by the winds, by wandering birds, propagated by the subtle horticulture of the elements which are its ministers and servants, it softens the rude outline of the world. Its tenacious fibres hold the earth in its place, and prevent its soluble components from washing into the wasting sea. It invades the solitude of deserts, climbs the inaccessable slopes and forbidden pinnacles of mountains, modifies climates, and determines the history, character and destiny of nations. Unobtrusive and patient, it has immortal vigor and aggression. Banished from the thoroughfare and the field, it bides its time to return, and when vigilance is relaxed, or the dynasty has perished, it silently resumes the throne from which it has been expelled, but which it never abdicates. It bears no blazonry of bloom to charm the senses with fragrance or splendor, but its homely hue is more enchanting than the lily or the rose. It yields no fruit in earth or air, and yet should its harvest fail for a single year, famine would depopulate the world."

The forest, however, in this strife for the mastery or possession has its peculiar advantages. From its deep shades it excludes the grasses. The lack of light and warmth in the twilight of vast forests,—"the boundless contiguity of shade,"—partly paralyzes vegetable growth of all kinds, and nearly obliterates all traces of grass. The shrubs and undergrowth are dwarfed into insignificance, and appear unwelcome, like lank beggars in a lordly court.

Grown trees, however, with their spreading branches, bearing coronals of leaves, yearly increase in this manner their own bulk, and at the same time deepen the shade that deprives the shrub or sapling and grass of their bread of life. By this *regime* the forest attains its majesty, and maintains its regal splendor for centuries. By this economy, with the steady bracing and blending of woody fibre, the tree trunk lengthens toward the sun, increases in strength and beauty, and contributes to man his house on land, and his ship at sea. On the border, between the forest and plain, both grasses and trees show the decimating effect of antagonism in the struggle for existence. Trees of high growth and rank never grow into columns; but, with branches

near the ground, dwindle into groves in bush forms. Among them, but with abated force, the grasses spread, and afford only tolerable pasture. It is evidently a drawn battle, or an attempt to compromise under a flag of truce.

The effect of annual fires over prairie areas is nearly uniform. It is one of the constant forces, varying, of course, in direction and power with the wind, but passing over, year after year, nearly the same areas, and meeting the same barriers to stay its progress, thus keeping the same border line between the two kingdoms. These fires may have originated ages ago from the ordinary lightning, or what is more probable, they were caused by the same means that now maintains them, viz.: human agency. From time immemorial the Indians have, generaly in the autumn of each year, fired the prairie or grass plains, producing thereby that peculiar phenomena called Indian summer. By these annual fires they secure two results, viz.: First. The game is driven to the timber, where it can be more easily taken; and second, the grasses being burned, the bare prairie affords free vision against invasion, and also facilitates speed, whether for assault or retreat. Compelled thus by a two-fold necessity to annually burn the prairies, it is easy to see that they must have maintained for ages the areas that were fixed by natural barriers in the indefinite past,—established with no prospect of change, except by a change of policy under a different race of men. In this case, the successful invaders or the present vast population of farmers must speedily revolutionize the Indian policy, and the former boundaries between prairies and groves.

Under the new regime, timber, being in universal demand, will be introduced upon every farm. The annual burnings will be generally avoided, and in general, the tendency towards forests will be prospered. As would be naturally supposed, all streams having a general bearing north and south would have vigorous groves or timber belts on the east side. If the streams have wide bottoms with tortuous courses, the groves will be

larger and occupy both banks; also, at the junctions of streams where sweeping fires could not penetrate, or where excess of moisture would keep the grass rank or damp after annual burnings; in general, we find on all streams, large and small, just that condition of both grove and prairie which exactly conforms to the interaction of all these forces, modified by the protection of these barriers.

"The cause of the absence of trees on the upland prairies is the problem most important to the agricultural interests of our State, and it is the inquiry which alone I propose to consider, but I cannot resist the remark that wherever we do find timber throughout this broad field of prairie, it is always in, or near the humid portions of it—as along the margins of streams, or upon, or near, the springy uplands. Many most luxuriant groves are found on the highest portions of the uplands, but always in the neighborhood of water. For a remarkable example, I may refer to that great chain of groves, extending from and including the Au Sable Grove on the east and Holderman's Grove on the west, in Kendall county, occupying the high divide between the waters of the Illinois and the Fox rivers. In and around all the groves flowing springs abound, and some of them are separated by marshes, to the very borders of which the great trees approach, as if the forest were ready to seize upon each yard of ground as soon as it is elevated above the swamp. Indeed, all our groves seem to be located where water is so disposed as to protect them, to a greater or less extent, from the prairie fire, although not so situated as to irrigate them. If the head waters of the streams on the prairies are most frequently without timber, as soon as they have attained sufficient volume to impede the progress of the fires, with very few exceptions, we find forests on their borders becoming broader and more vigorous as the magnitude of the streams increase It is manifest that land located on the borders of streams which the fire cannot pass are only exposed to one-half the fires to which they would be exposed but for such protection. This tends to show, at least, that

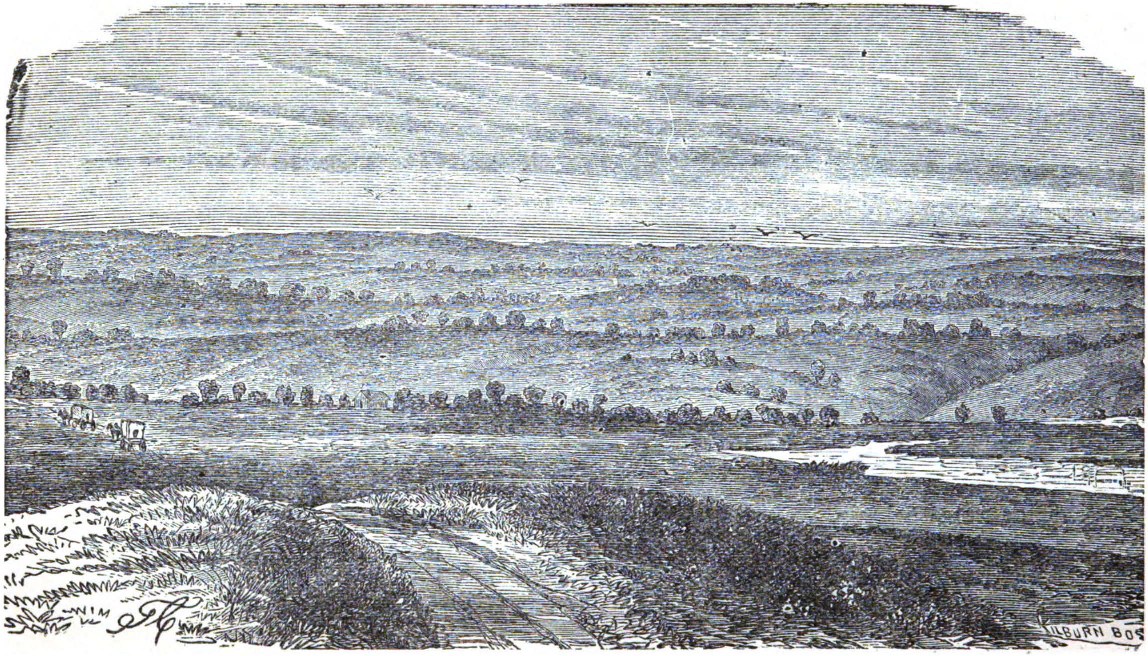


Plate 9.—Rolling Prairie with Timber.

if but one-half the fires that have occurred had been kindled, the arboraceous growth could have withstood their destructive influences, and the whole surface of what is now prairie would be forest. Another confirmatory fact, patent to all observers, is, that the prevailing winds upon the prairies, especially in the autumn, are from the west, and these give direction to the prairie fires. Consequently, the lands on the westerly sides of the streams are the most exposed to the fires, and, as might be expected, we find much the most timber on the easterly sides of the streams.

Indeed, we venture upon very much whenever we assume to explain all the laws by which nature works out all her great results, or to state all the causes which may have tended to produce this one result. One cause, or set of causes, if I may use the expression, may have produced it in another place. While we may have clear proofs of the existence and operation of some of these causes, we may not deny that others, and many of them, have been operating for ages since the prairies became dry land, first to promote the growth of one kind of vegetation which by other causes has been destroyed and replaced by another; and, for aught we know, this process may have been many times repeated. In contemplating these works of nature we are too apt to confine our reflections to yesterday. When we pause and let the mind run back through the vista of time until it becomes bewildered and lost in the contemplation of distance without end, we are then prepared, when we return to complete consciousness, to appreciate that the growth of the oldest tree of the forest, when considered in relation to past time, has been as rapid as is that of the eastern magician, who plants the seed of the orange before your eyes, and while you yet look, the tender plant springs from the ground and grows up to a full sized tree, bears blossoms which fade and fall, and the green fruit appears in their places, which immediately grows to its full size, matures and ripens, and you are invited to pluck and eat, and you find in your hands a veritable orange, rich, juicy and nourishing. I

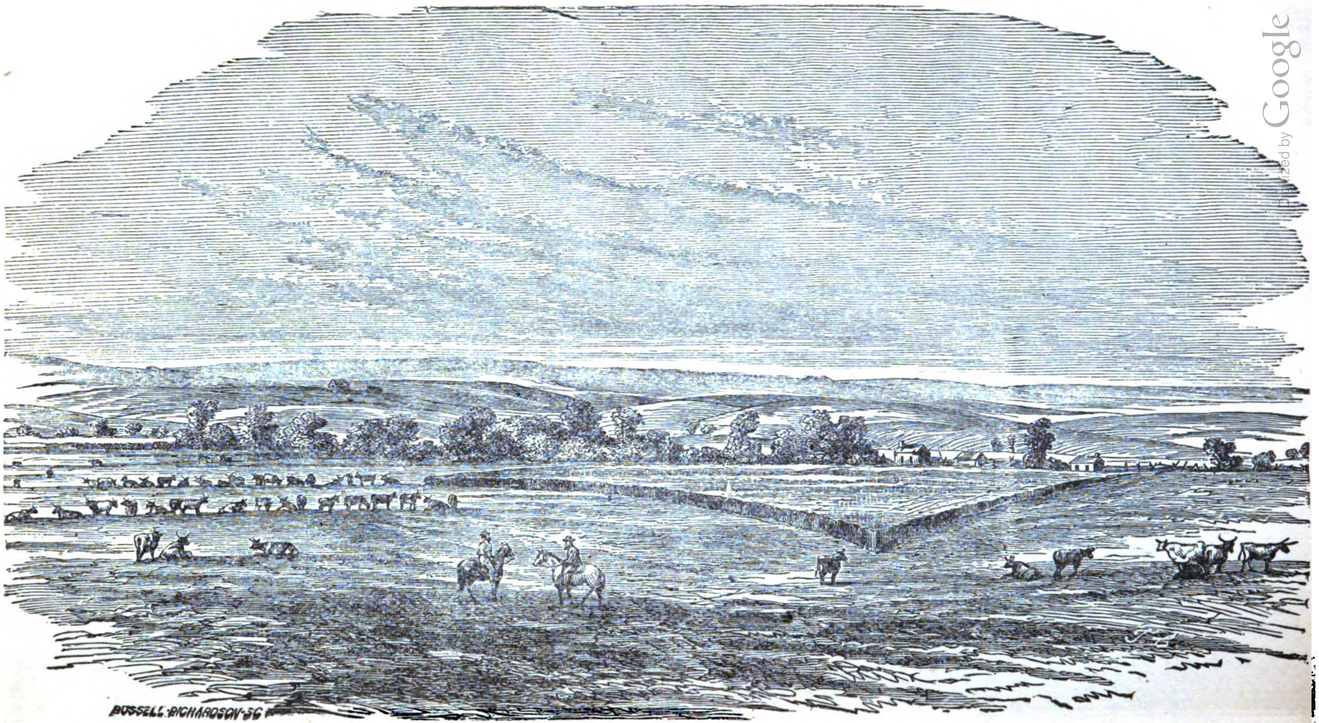


Plate 10.—PRAIRIE VIEW, LANCASTER COUNTY, NEBRASKA.

say this is but the history of our oldest forest trees when contemplated with reference to the ages that must have elapsed since this land emerged from the bosom of the waters. During all these rolling years surely there has been time enough for the prairies to have been clothed with forests, and again denuded of their trees, and for the process to have been many times repeated by agencies not beyond our comprehension of nature's laws. But because this may have been, I have no warrant for saying that it has been, for the want of tangible proof of the fact. I may even assert its probability, or my belief that it has been so, but at last it is but conjecture, and as such alone may be suggested. Still we cannot shut our eyes to the fact that the study of the geology of this country, in some of its departments at least, is yet in its earliest infancy. May we not reasonably hope that its maturity will develope facts which will dispel the obscurity which now veils many subjects of most interesting inquiry, and enable us to read the past in a clear and convincing light? For instance, the prairies abound in beds of peat, of greater or less extent, some of vast proportions. As yet these are comparatively sealed volumes of history, which, when they shall be opened and read, as they have been in what we call the older countries of the world, will reveal the records of by-gone ages. What treasures of truth have been revealed by the examinations of the peat-beds of Denmark, to which reference may be made as quite appropriate to the present inquiry? These are at depths varying only from ten to thirty feet, formed, like ours, in basins in the drift. They tell us plainly, as if written in a book, of the different successive forests which there have lived and flourished, and finally disappeared, and been succeeded by others. The oldest which they reveal is the Scotch Fir, (*pinus sylvestris*) which is not now found in Denmark, and cannot even be domesticated there. Then succeed several varieties of the oak, one after another, and so on until finally at the last the beech is found, which is still the common forest tree of Denmark, and so it was two thousand years ago, as we learn from

written history. How admirably do we here find united into a long chain of history the various links which we see deposited in these beds of peat, the last of which being united with and interpreted by written history enable us to read all the rest, with almost as much confidence as if the written history extended back to the time when the first layer of peat was deposited. How shall we restrain our impatience till the seal shall be broken to similar volumes of history, which lie profusely scattered all over prairie land, waiting to be opened and read by the discriminating geologist?"

"Through the changes of accumulating ages the soils of our prairies and woodlands have, no doubt, at different times been adapted to the healthy growth of almost every variety of vegetation of the temperate zone, both herbaceous and arborescent; nor do I think it unreasonable to suppose that not only our present prairies, but the great forest land covering the plains which spread away clear to the foot of the mountains east of us, may have been many times clothed with heavy forests, and these again denuded to naked praires. It is a familiar fact that places have been found covered with what appeared a primeval forest of hard wood, showing abundant remains of a growth of pine, which must once have occupied the same place. No fact is better settled in agricultural science than that any particular crop of vegetation, if long continued, will in time exhaust the element necessary to its vigorous growth, when, if vegetation requiring a different element be substituted, it will grow with peculiar luxuriance. Hence the necessity for rotation of crops, which has been thus enforced by the laws of nature herself long before man appreciated its utility or adopted it in practice."

Dr. Hough, in his recent work on the Forests of the United States, estimates that in thirty years we shall experience a timber famine; meaning, of course, that we shall by that time, say A. D. 1910 or 1920, have used up all the now available forests. In this estimate he notes the amount of wooded acreage now existing, and the rate per cent. of disappearance, and he cites in

illustration the pine forests of Canada and the Northern States, Wisconsin, Michigan, the middle timber region of Southern Illinois, Indiana and Missouri; also, Tennessee, Kentucky and the great timber belt of the Gulf States. He states further that after thirty years we must draw our uncertain supplies from Oregon and Alaska. But this prophecy need not come to pass. Warned already by the spectre of want, innumerable groves are being planted in all the Western States, so that many kinds of timber are now increasing. Railroad companies, foreseeing the evil day, are planting timber belts. In this work of restoration they are guided by a knowledge of what can be made to grow for specific purposes. It is therefore most probable that many thousands of intelligent farmers will make a specialty of tree planting in groves of ten, twenty and forty acres of assorted timber, so that if we have a timber famine, according to Dr. Hough, no interests will suffer from it. For my part, under the usual vigilance of demand and supply, I cannot foresee the time when there will not be an abundance of timber for all uses. It is indeed far more probable that the timber facilities of the next century will exceed those of the present day, because they will be the direct result of intelligent enterprise. The historian of our next Centennial, writing of our resources, will use the following or similar expressions: "Our ancestors, from 1620 to 1875, "and down to 1900, had native forests, from which they drew "supplies. But with far better economy of land and labor we "now grow only what we want, accordiug to the demand, like "other products. It matters little that we produce no lofty Se-"quoias, nor mighty oaks, nor magnificent conifers, or lirioden-"drons, such as our fathers knew. The uses of iron and other "material for nearly everything, render our grove grown timber "equal to all uses." I much prefer a higher prophesy, that conceives of the earth growing more beautiful and useful under advancing civilization, not less in the matter of forests than in other matters of husbandry.

The new science of forestry has arisen within a few years, in

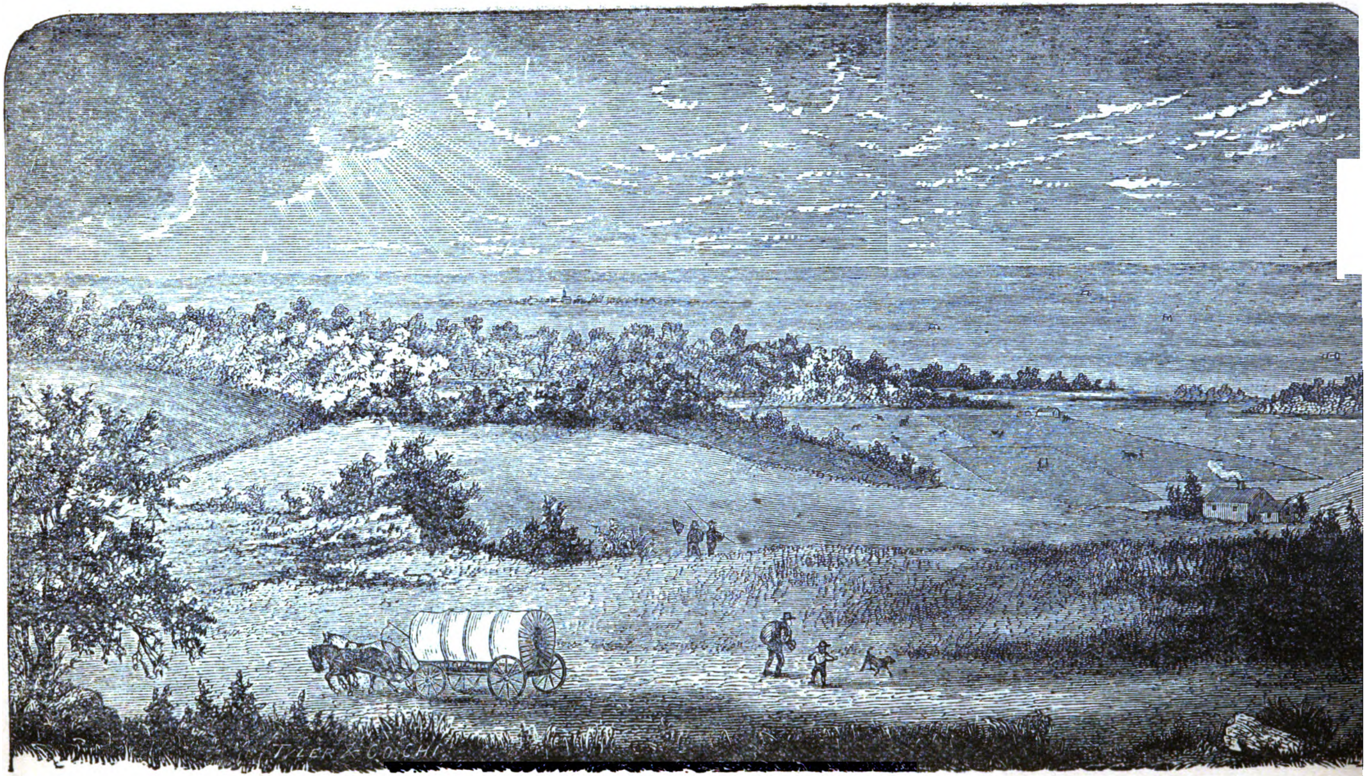


Plate 11.—Rolling Prairie, Elkhorn Valley, Nebraska.

answer to our country's present needs and demands. Its field of research and application embraces every question of soils and their relation to timber growth. In its study and practice are already enrolled the best talent and skill of the commonwealth, and already are we far on the way to success in this new industry. The modifying effects of climate in determining tree and plant growth has been well expressed by Prof. Bessey, of the Iowa Agricultural College:

"Our climate is a dry one, subject to great and sudden changes of temperature. These characteristics of climate have much to do with the modifications which every botanist notices in the plants of the Northwest. Our plants, in general, are rougher, harsher, harder, and possessed of more leaf-surface than their relatives in moister and less changeable climates. What these climatic and other conditions have done for the native plants they will do for the introduced ones, and if any particular one differs too much from the typical Northwestern plant, or for some reason cannot undergo the modifications which the aforesaid conditions tend to bring about, then that plant will die. These influences of climate are well known to the botanist and zoologist, and there can be no reasonable doubt as to their potency. There is but little doubt that one great and preponderating reason why the ordinary Eastern evergreens cannot be made to survive when planted on our open prairies, is to be found in the fact that they are natives of moister and milder climates."

The uniform tendency of timber growths to extend themselves has often been observed in all the prairie States. Says Dr. Sternberg, of Kansas:

"On many of the small streams there is a more dense growth of timber than when the country was first opened to settlement. The necks of creeks (having a narrow lining of timber) formed by their numerous windings, are being gradually covered with trees; and the shade and mulching afforded by these trees produces congenial conditions, under which numerous others are constantly springing up, and thus the timber area is enlarging. Sometimes additions are made to this area by a slow but sure process, viz: To furnish the necessary shade and mulching for the growth of tree-seeds, let the surface be covered with tall grass. From this condition will spring up some such shrubs as alders, or wild plums, but most commonly sumac. Then comes forth varieties of larger growth, from seeds, as the elm, ash or box-alders, and other varieties

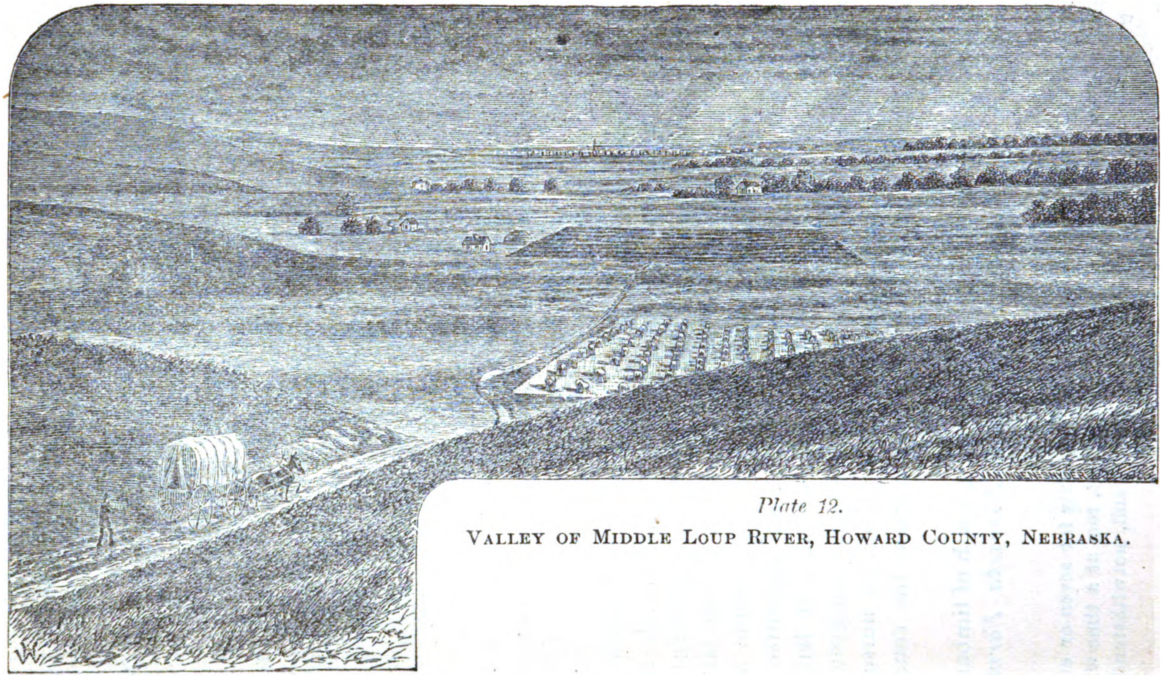


Plate 12.

VALLEY OF MIDDLE LOUP RIVER, HOWARD COUNTY, NEBRASKA.

may follow, and in a few years the latter kinds will overtop, and by their shade destroy those that first gave them shelter, and hence the increase of forest area."

*"The manner and progress of the encroachments are familiar to all. The hazel is the usual pioneer in these encroachments, though sometimes even this is preceded by the wild apple. No one can at this day travel two hours on any of the railroads through our prairies without passing some grove of timber bordered by considerable belts of hazel, among which, not far from the outer edge, young forest trees will appear, and these will be observed larger and larger as they are farther and farther from the edge of the grass, and are found nearer and nearer the original forest, and this where there has been no cultivation. This is the usual though not universal appearance of the surroundings of the groves at the present day. Sometimes, no doubt, large trees will be found as advance sentinels, standing out quite in the prairie, but how they have been able to maintain their ground there we may not at all times be able to explain. Such instances are rare exceptions. The general rule is, that the hazel is in the advance, and from this we may safely conclude that this shrub can maintain the struggle for life with the prairie grass better than forest trees, while in turn it succumbs to the latter. In the hazel-rough the seeds of the trees find accessible soil, where the young plants are indifferent to or are benefitted by the shade. In time they rise above the hazel, and at length grow to sufficient size to constitute a forest and shade the ground, which destroys the hazel, which was their protecting nurse in infancy. The facts stated, I think, clearly warrant the conclusion drawn."

As evidence of the easy, cheap and rapid growth of timber in the Nebraska prairies, we copy from the *Nebraska Farmer*, 1877:

"Twenty years ago cordwood sold in Nebraska City for seven or eight dollars, and sometimes ten dollars a cord, and that, too, at a time when her population was not one-fifth what it is now; and, notwithstanding

***Judge Caton.**

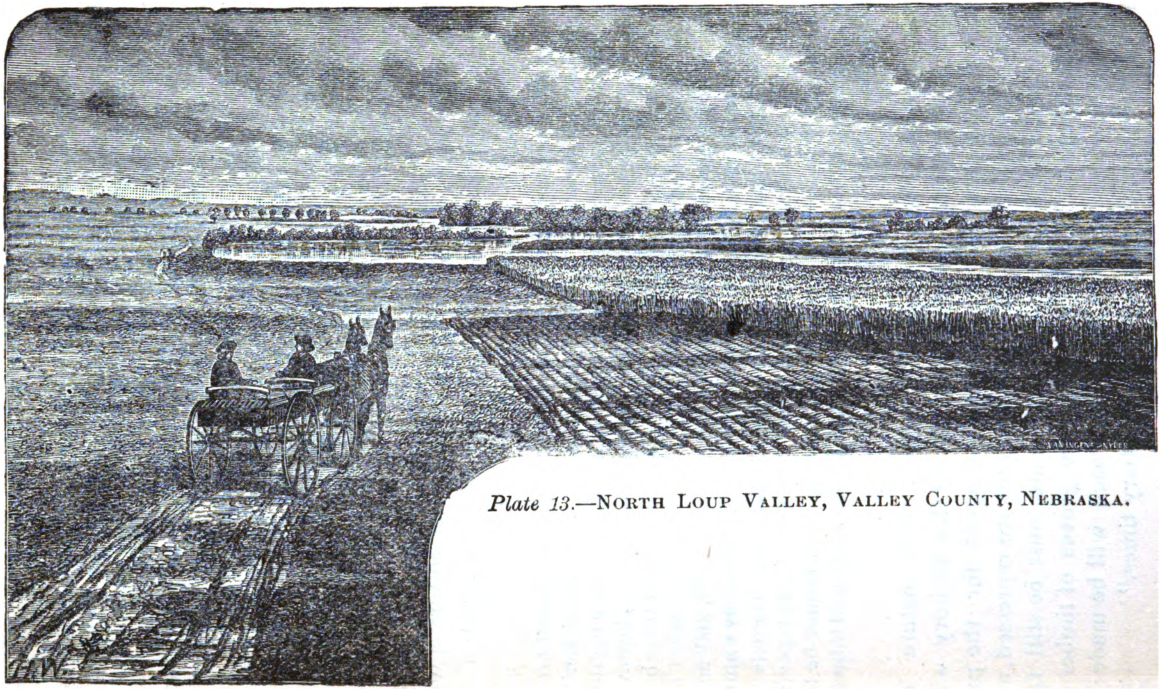


Plate 13.—North Loup Valley, Valley County, Nebraska.

the demand for fuel is at least ten times greater now than in 1857, it is a fact that good merchantable wood can be bought in our streets for from three dollars and fifty cents to five dollars a cord. The reason of this is simply from the fact that the natural groves have been protected from fire, and the artificial groves are turning out an abundance of good wood, such as the necessities of the country demand for fuel. It will agreeably surprise any one not acquainted with the fact to know the amount of timber one acre of land will produce in the course of ten years. Mr. Richard Justice, who came here in 1857, and planted about ten acres of cottonwood in 1859, has one or two outhouses built from hewed logs taken from that grove, and the family have all the fuel they need. Hundreds of such cases might be mentioned throughout the eastern portion of the State did space permit.

The adaptation of western prairie soils to tree culture is well illustrated by Judge Whiting's (Western Iowa) account of his own experiments:

"I have, in belts around my fields, varying from single to twenty rows of trees, mostly planted 4,356 to the acre, about forty acres of timber. The trees in these belts vary as to time of planting; some are eighteen years old and some only one year planted; the greater portion, however, are from five to twelve years of age. The needed thinning of these belts furnishes all the wood that is wanted on the farm, including stakes and rails to keep the fences in repair, posts for all repairs needed, and many for new fences I annually build in extending my farm. When my walnuts get a little larger I will have all I need and many for sale. There is not a stick of needed timber on the farm, from a pea-brush, a grapevine-stake, or a binding-pole up to a fair-sized saw-log, that cannot be had from my groves, without cutting a single tree that does not need thinning out from the groves."

"It is wonderful" says Prof. Aughey, "how nature responds to the efforts of man for reclothing this territory with timber. Man thus becomes an efficient agent for the production of geological changes. As prairie fires are repressed, and trees are replanted by the million, the climate must be still further ameliorated. When once there are groves of timber on every section of land in the State, an approach will be made to some of the best physical conditions of tertiary times."

If it be considered a great achievement to convert a desert like Sahara into oases, so numerous that they finally overspread all the land, then there is no desert. If we can, as our present progress indicates, join farm to farm, from the Missouri river to the foothills of the Rocky mountains, covering the desert lines of our learned experts with fields of corn, wheat and other products of agriculture; if we can in any part of our domain command the forest to come forth in form, variety and value as we will or determine; or, on the other hand, say to one kind of grass: "Come forth as wheat;" and to another grass, "Be corn;" to another, "Be barley;" to another, "Be rye;" to another, "Be and appear only as timothy;" and to another as millet with increased productive power under culture of thirty, sixty and one-hundred fold—it would appear, in the light of these already accomplished facts, that there are no limits to man's dominion over external nature; and especially no limit to his power to convert the most unpromising surroundings into abodes of beauty and wealth, or competence and peace. With the least, yet earnest solicitation, the wild prairie disappears, and lo! the new farm and forest brighten in its stead. Because it is in our power to so transform our vast and unoccupied domain, it is our highest duty not only to do so, but to encourage all means that will enable us most speedily to reach this desired result.

CHAPTER VIII

THE 100TH MERIDIAN AND BEYOND.

Contradictory Estimates of the Value and Uses of Our Public Domain—Progress of the Plow—Review of Maj. Powell's "Arid Regions"—Water Resources of the Northwest—The Real and the Ideal—Correspondence.]

PURSUING our inquiries, according to a natural method, as will be noted by a brief review of the preceding chapters, we will consider next the present physical condition and future economy or productive ability of that vast western region of the United States being and lying west of the 100th meridian.

To some, a discussion of this topic in a space so limited may seem objectionable, but the questions involved relate so directly to Western Nebraska, Kansas and Colorado, that in presenting it we yield to a public demand, more especially urgent from the conflicting views now entertained in regard to the future status of our vast public domain.

I have selected from Gen. Hazen's article in the North American Review, 1878, a few extracts, as best representing the American desert literature, for which there seems to be a demand or craving, especially in eastern circles, for a reason similar to that which calls for stimulants, and which is proof of a vitiated taste instead of a healthy condition. Gen. Hazen, like many army officers, had preconceived the Great West as a desert—a decision not to be overcome or set aside by any number of farms or amount of farm products. He says:

"The eastern half of Kansas, or rather until we reach the neighborhood of the 98th meridian about Fort Harker, has an excellent soil, and although occasionally subject to drought, has generally a sufficient rain fall, a fair amount of timber and abundant crops. But at this meridian a very perceptible change takes place. The altitude grows greater.

Steadily as we go west the soil becomes more and more arid, the native grasses shorter, the streams less frequent, and after passing Fort Hays we get beyond the country suitable for agriculture. This section, extending west nearly to Denver, is that known as 'The Plains.' It is a succession of gentle undulations, without timber and covered with buffalo grass, which is a short native grass, seldom growing more than two inches high. It is very nutritious; almost the exclusive food of the buffalo. Maturing in June, it is dry and brown the remainder of the year.

Now passing rapidly over the route of the 41st parallel, beginning at Omaha, we find for the first two hundred miles, or to Fort Kearney, one of the most beautiful portions of the continent. The Platte and Elkhorn valleys cannot be surpassed in richness by any soil in the world, and greatly resemble the Rhine valley. A great number of small streams water this region. There is a small quantity of timber and a good rainfall. There has never been a failure of small grains, and spring wheat is almost a certain crop in the twelve years I have known this country.

The winters are severe, but easily provided against. Westward from Fort Kearney we see precisely the same condition of soil, dryness of atmosphere, insufficient rainfall and general aridity noticed on the same meridian (98th) in Kansas, Indian Territory and Texas. The Platte has a narrow valley, which can be irrigated at considerable cost, and good grazing is always found near the streams. During all this progress from Omaha we have steadily ascended, and some sixty miles west of Cheyenne is the summit of the Rocky Mountains. The quantity of agricultural lands in Wyoming is too inconsiderable and too little known to admit of any reliable computation, but it is proportionably less than in Colorado, while Nebraska corresponds with Kansas in this, that while the eastern half is very valuable the western half is worthless."

Along the 98th meridian the rainfall is from twenty-five to thirty inches, and on the 100th meridian it is from twenty to twenty-five inches; as we near the mountains, from ten to fifteen inches, and even higher on the more elevated table lands.

In the western part of Montana and Northern Idaho there is a good deal of timber and sufficient rainfall to produce crops without irrigation. The phenomena of the formation and rapid growth of new, rich und populous States will no more be seen in our present domain, and we shall soon face a condition of facts utterly new in the economy of the country, when not new but old States must make room for the increase of population, and thereby receive a fresh impetus. And the old song of "Uncle Sam is rich enough to give us all a farm," will no longer be true unless we take farms incapable of cultivation.

We have reached the border all along from Dakota to Texas, where land for nothing is no cheaper than good land at $30 per acre. From the 100th meridian to the Sierra Nevada Mountains, a distance of 1,200 miles, there is not more than one acre to the hundred that has any value for agricultural purposes, or that will sell for the next one hundred years for any appreciable sum. Moreover, for one hundred miles before reaching that meridian there is comparatively very little good land."

In the summer of 1869 or 1870, during the first construction of the Kansas Pacific Railway, I saw at a water station in Western Kansas, not far from the Colorado line, on the 102nd meridian, a tall stalk of growing corn. It was doubtless chance sown from a grain car, but regardless of propriety or proper paternity, there it was, a live stalk of corn, like a minature palm, growing in that desert soil, its broad leaves rustling in the wind with as much assurance of vigorous growth as if in Illinois or Iowa. It had two ears whose silk tips beneath the tall tassel or plume indicated that it would have its career according to the rule, "first the blade, then the ear, then the corn in the ear."

The eastern excursionists on the same train, who had, in terms that denoted more strength than politeness, disposed of the whole region as worthless—an eternal desert, etc., saw in this apparition an argument that kept them silent, especially on the subject of soil and corn raising; but the exciting buffalo hunt doubtless dissipated the impression it should have made. But on the testimony of this living witness I took an appeal from the decision of Fremont and Hazen, preferring to trust my eyes and believe what I saw rather than the hasty and sweeping conclusion of a prejudiced martinet.

Beside this stalwart stalk of corn also grew a huge Canada thistle (Cirsium Arvense). Soon after our arrival (Little Raven) the Cheyenne chief, came to the station with a pony train of buffalo skins to exchange as usual for firewater, tobacco, powder and guns, especially the latter because most needed in their favorite pastime of scalping the unwary white man. Comparing the corn and thistle growing side by side, one could

not resist a preference "for the survival of the fittest," nor see any harm in the destruction of the entire tribe of thistles. Useless, like the thistle, it was clear that the Indian had no stronger claim. To civilize him and to make the thistle bear figs are similar tasks, which may properly occupy the minds of Utopian dreamers.

The soil of the extreme western counties of Nebraska, Dundy, Chase and Hitchcock, on the 101st and 102nd meridians, is the same by analysis as the soil of Saline, Gage, Richardson and Johnson counties, in Southern Nebraska. For hundreds of miles we find an unvarying top soil of loess two to five feet deep, slightly colored with burnt or decayed vegetation, with a subsoil identical in composition, but having its original light brownish-yellow hues. It is sometimes called the "bluff formation," because first noticed in the vast line of bluffs on the Missouri river. But since it has been proved by Professor Aughey to be identical with the loess or rich soil of the Rhine valley in Germany, named loess, this name is coming into general use. The same soil extends over a large area also in China, where a dense population exists. Next to the loess deposits of China in size are these deposits. In Nebraska they occupy the entire State, as well as the northern portion of Arkansas. The northwestern portion of Nebraska, or the Niobrara region, as far as explored by competent observers, has the same class of soils, viz., the loess. It is, however, in hilly regions, on the great divides, characterized by ridges or hills, which, having the appearance of sand, were formerly supposed to be sand-hills or dunes. They are, on the contrary, merely areas of loess, as capable of grass and grain growing as the adjacent regions. Of the forty-nine millions of acres of Nebraska, I would not deduct over four million acres of the northwestern portion as non-productive. This is a small ratio, compared to the non-arable regions of the Eastern or Middle States, where, over vast areas, scarcely one acre in ten can be cultivated.

Of fifty letters and affidavits from farmers who have prosperous farms and homes on and beyond the 100th meridian, I give you one dated Lyndon, Neb., Aug. 26, 1878, in which he says:

"My oats threshed 65 bushels and 32½ lbs. per acre, and weighed 49 lbs. per bushel; wheat (white) yielded 36 bushels 35 3-10 lbs. per acre, and red wheat 25 bushels per acre. H. J. Remington."

Upon this noted meridian, too, were crops of wheat, thirty bushels per acre; oats, seventy bushels; barley, sixty-two; rye, forty to fifty; and corn from fifty to seventy-five bushels per acre for the crop of 1878, the date of our visit being July of that year.

The crop surface on the western border of settlements for 1879, extending north and south through Dakota, Nebraska and Kansas, make a strip or belt ten miles wide and one thousand miles in length. During all the previous years and ages only sparse grass, in tufts or patches, has partially covered the ground, but now the new carpet of green, growing crops, for the first time wholly overspreads and shields the earth from the sun's heat. The earth cannot be heated as before, and is less able to heat the air above it, and the air is, therefore, less able to contain its moisture. This being the fact over the entire area of growing crops, there must result a vast diminution of heat compared with former years. In other words, the crop surface, from sprouting to ripening—a period of four to six months—is a condensing surface, and will cause an increase of rainfall all along the line of farms from north to south, increasing in amount until the average measure of precipitation is reached. Every year will show the work of a large army of pioneer farmers, who, armed with the plow, will overturn and conquer a wide belt of the wild prairie desert, thus preparing the way for a still further advance of rainfall.

In these new States and Territories the experience of farmers proves the following results:

1. The regular increase of precipitation, in periods of years, westward from the Missouri river.

2. The ratio of increase bears a direct ratio to the steady increase of farming and cropping.

3. The relation here stated is that of cause and effect. In other words, rain follows the plow. Across the States of Nebraska and Kansas, from east to west, over 300 miles, the plow has advanced in spite of prophetic starvation. The first settlers, twenty-five years ago, placed the desert limits just west of the Missouri river counties. These being occupied the desert line was established on the Big Blue, seventy miles beyond. But the farmer invaded the Big Blue Valley, and the desert line was established near Kearney, 190 miles west of Omaha. But the irrepressable plow broke the barrier in so many places that the desert-makers fled with their line to the 100th meridian, determined to have and enjoy a desert. But hordes of farmers have gone far beyond and secured farms whose products equal those of Iowa or Illinois.

There being really no reliable line or meridian which can be named as the boundary of our mythical American desert, I do not hesitate to say that it will never be found. There is no desert, neither is there any foundation in fact for the terms "non-farming," "non-irrigable," and "pasturage lands." These flimsy barriers have been interposed by wiseacres, kid-gloved experts and closet-philosophers, but the farmer with his plow tears them asunder, leaving us to remember the experts only as charlatans or quacks.

It has become evident to the people of the Northwestern States that there is a powerful influence working against the present system of distributing and occupying public lands, and we, who know the antipithy that exists on the frontier between the ranchmen and farmers, have no trouble in detecting the main spring of the movement.

The owners of the great herds of cattle are constantly obliged to retreat before the immense army of emigration from the Canadas, the Eastern and Middle States, and especially from Wisconsin, Illinois, Iowa and Minnesota.

Coming with their families and their farming outfit, generally without previous inspection, they become squatters upon any lands not taken at the land office.

As the land laws are impartial, who comes first is first served, and the herd-owner, though a millionaire, as some are, is, much to his disgust, forced further out on the plains.

The reactions that follow are obvious. The ranchmen or herders insist that the country will never raise grain, is only fit for cattle and sheep, is a desert, without water for irrigation, and insufficient rain. It is by nature the herdsman's country, and the national law must be made to coincide. To bring these laws into effect is the animus of the present land movement, and to prepare the way for it is the object of the public land commision sent out by the last Congress. This commission have made their preliminary report, full of desert, as usual. The report to Congress was, of course, a foregone conclusion, and the total expense of it ($10,000) might have been saved, because it could have been gotten up in Washington by the powerful ring, who are determined to force these lands from their present equable distribution in farm sizes, in quarter sections, into large tracts or districts, as may suit the aristocratic tastes of the lords of the herds. They propose an act of Congress enabling persons to lease for herding or grazing purposes, thus remunerating the government for the use of the lands. The prize of this contest is the control of nearly 500,000,000 acres of land in the heart of the republic, which under the present laws will be taken up by farmers.

The Public Land Commission are working, vi et armis, with the wealthy combination of cattle kings, and both present their claims in their report that is proved to be false by every one of the 100,000 new occupants who last year carved his new farm out of these very " non-farming " lands so greatly coveted.

The capitalists, too, have lately been converted to the real value of "Desert America," and by their present investment of scores of millions of dollars, prove the strength and sincerity of their new found faith.

Only eight years ago—being one of an excursion party—chiefly the pioneers of the M., K. & T. R. R. from New York City, I made an extended tour over the plains. Mayor Opdyke said: "The country is indeed beautiful, but what a pity it is so worthless. Is there not some way to overcome this desert condition? It must remain a waste thousands of years. The Indians are welcome to it if only they will keep it." Messrs. Skiddy, Schell, Parsons, Dickinson, and other men of great wealth, returned from the Sahara confirmed in their traditions, saying "It will never be worth a dime per acre."

To-day, ten years later, the New York capitalists are pushing railway lines and branches with unparalleled rapidity, eager to be first in possession of the same country, no longer a desert, dry, sterile, worthless, but, as they now know it to be, the best portion of the continent.

The Boston capitalists were quite as blind as the New Yorkers. Twelve years ago the wise men of the "Hub" projected their first Nebraska railroad, from Plattsmouth to Fort Kearney, nearly 300 miles, based upon the usual land grant of 12,800 acres per mile of track. But in this desert Nebraska, as they judged, the less land the better. In the bill conveying the grant it needed only five or ten lines, or a score of words, to have secured gratis the entire route through the great Republican valley, with the accompanying grant of over 4,000,000 acres of the richest lands in America, but by them at that time not considered worth asking for. And now, after ten years, the aforesaid wise men of Boston, in the autumn of 1879, passed over the same route with a corps of engineers to choose the route, purchase the right of way, and make ready to spend $10,000,000. They *knew* the country west of Kearney would never be habitable except by Indians, gophers and owls. Just as their forefathers, 150 years ago did in reluctantly granting a charter for a turnpike from Quincy, Mass., 200 miles into the wilderness. They said "it would never be used."

Wise as the seven of Solomon, their adherence to the traditional lies and theories of the American desert cost them a princely estate worth $15,000,000.

West of the 100th meridian, in Kansas, there are 13,760,000 acres, or more than one-fourth of the area of the State. In Nebraska, west of the same meridian, we have 17,600,000 acres, or nearly one-third of the State. Of these lands a large part belong to the government, and are subject to homestead preemption and timber-claim entry, in separate tracts of 160 acres. They are being quite rapidly taken up by actual settlers on the entire length of the frontier line, regardless of the verdict of the government experts, who are far more expert in drawing pay and rations than in furnishing the people with reliable information.

The desert country, or American desert, reported as being and lying west of the 100th meridian, has no real existence.

It was reported formerly to be a desert from its comparatively dry appearance. The entire region west of the Missouri river was for years held under the same reproach. Even now thousands of people in the Eastern and Middle States have their desert ideas on the great western plains. A letter recently received from a gentleman in Zanesville, Ohio, inquires what is the cost of irrigation in Eastern Nebraska. His neighbors, of course, must be equally benighted. No missionary effort can relieve such ignorance. Most of the "desert" ideas are traditional. Our fathers knew it as a wilderness given up to Indians, buffalo and coyotes. When the hegira to California began ten thousand teamsters crossed and recrossed these plains. They saw no attempt at farming except in the river (Mo.) counties, and their verdict was swift, viz: That the entire region was worthless, except to fence out the California earthquakes. They traveled the divides, and seeing no water for long distances, they were quick to decide there is no water, and when now and then finding it with brackish taste in a pool at some crossing, they called it alkali, and at once cursed or alkalied the whole country. For

years the only source of information was reports of tourists and teamsters, abundantly sandwiched with our national oath. Even excursion and hunting parties, whether from Britain or Boston, had the same stereotyped curse for the country, viz: A dry, sterile, alkali region, forever incapable of use for farming purposes. And now to have this decision reversed by magnificient crops of corn, wheat, oats, and barley, in many instances exceeding the productive ability of the renowned valleys of the Mohawk, Geneseo, Muskingum, the Miami, etc. This is a state of affairs not to be endured. But the truth is mighty and will prevail. The young men of the East, less troubled with desert ideas, are waking up to the new enterprises of farming or herding in this the most successful region on the continent—that is, a region where success will follow effort with the best rewards.

The government experts, so-called, have not studied the middle region between the Missouri River and the foot-hills of the Rocky Mountains. Whatever they have put on record in their reports mostly concerns the mountainous regions of Wyoming, Colorado, Utah and New Mexico.

The plains or middle country of Dakota, Nebraska, Kansas, Eastern Colorado and Wyoming have either been wholly neglected or dismissed, after hasty visits, with a brief report made up of most superficial and erroneous observations.

The term "alkali" is frequently applied to soils in the Western States and Territories, and is intended to denote a soil so charged with some indefinite salt or precipitate as to render it useless for crop purposes. It was first used indiscriminately by the vast horde of teamsters who, in crossing the plains, constantly cursed the apparently dry and barren country. As it originated in prejudice, so it turns out to have no real or practical existence. There are occasional patches, sometimes an acre, more or less, generally found in the slight depressions that occur in bottom lands, which on first plowing yield only diminutive crops; but subsequent plowing and cultivation readily dispose of them. They are occasioned by rainwater in these

depressions, remaining a few days, or long enough to render soluble some ingredients of the subjacent soil, which upon exposure presents a slight film of soda or magnesia. But these limited areas, so sparse as not to occupy one acre in 10,000 feet, hardly deserves mention. Also a chalybeate or carbonate spring may occasionally saturate the surrounding soil for a few rods. The alkali bug-bear has only this extent.

A thousand-mile journey to the west—from Omaha, through Nebraska, 400 miles, across Colorado and Wyoming, 600 miles, and into Utah at Great Salt Lake City—compels the intelligent traveler to conclusions not only irresistible but most cheerful as regards the future of the vast interior portions of our country. Through the Platte valley, which now is an almost continuous corn-field to Kearney, 200 miles, thence to North Platte, 90 miles, there is every proof that the soil of Nebraska—300 miles west of the Missouri river—is as rich and productive as the great body of land in Iowa, 300 miles east. The steady march of grain and grass crops, advancing step by step, for a quarter of a century, with harvests more or less as the years go on, has settled all the points in the affirmative. Along this route of 300 miles every farmer knows that there is no better corn land in the world; and if the yield this year is less than fifty bushels per acre he will admit his own negligence as the cause thereof. It is true there is not much cultivation beyond Plum Creek and Cozad, which are near the debatable border between the two kingdoms—one of farms and farmers, who are steadily advancing their lines westward, and the other of scattered herds and ranchmen, who reluctantly yield to the inevitable and make way for the compact wave of empire. Both in the Platte and Republican valleys every observer takes notice that the two great western industries, herding and farming, are separated abruptly, or only by a few miles; and it readily occurs to him that this sudden sundering of interests is not based upon any qualities of soil, present or absent, nor upon the supply of moisture —but that, on the other hand, herding limits or restrains farming

only by the rights of squatter sovereignty, or previous occupation. It is like one wave, never refluent, following another by a law as immutable as the force which sets the tide-waters towards the west is irresistable.

But we will, by truce, omit the debate, and roll on with our pleasant party over the great plains, up the rocky inclines, across the backbone of the continent, through the granite canyons, gorges and tunnels, and into the grand parks and plateaus, surrounded by magnificent ranges still white and brilliant with snow and ice. However, as if to settle certain very important questions for tourists and general travelers, and especially for the alert reporter who wants to make a note of the most striking facts, there are, at many stations on the route, actually as good, growing vegetable gardens as one can find on the moist lowlands of the river States. Possibly not one of one hundred takes in the significance of this fact. But, practically interpreted it means simply that all the soils, whether of valley or plain, or of the so-called mountain "desert," are not wanting in any important ingredient. It means, in short, that all these soils of the American interior are perfect in their composition as agricultural soils.

We obtained many measurements of common wells along the entire route, not only in Western Nebraska, but in the valleys beyond—Lodge Pole, the Laramie, Rock Creek, Bitter Creek, Medicine Bow, Muddy, Green river, Bear river, Weber river, and the streams of Salt Lake valley. The statistics gathered, both concerning the depth and the quantity of water, prove the existence of a vast supply of water for all ordinary purposes, at depths varying from twenty to one-hundred and fifty feet. This subterranean supply has always been ignored, but now, since water is often wanted at places beyond the convenience of a running ditch, a cheap well with a windmill or a common bucket or pump reveals the existence of water everywhere. This water exists in immense beds or strata of sand and gravel towards which it constantly gravitates from the annual mountain

snows or rain; and as it has taken ages for its accumulation and the construction of its reservoirs, it is not probable that modern use will sensibly diminish the amount thus stored in these countless natural cisterns in the ten thousand valleys of the great Rocky Mountain ranges.

We should not make narrow and hasty conclusions concerning the possibilities of the undeveloped portion of our western domain. In coarse and rugged garb Nature generally conceals her best gifts, whether of minerals or gems. We do not seriously complain because bread is not furnished us in loaves; on the other hand, we cheerfully accept the conditions of tilling, sowing, harvesting, winnowing, grinding, bolting and baking, and most of us are glad to get bread on those terms. In like manner, in preparing the farm and garden, the earth must first be subdued or relieved from the rough or natural condition inseparable from the rude forces that so nearly finished the great work of shaping and preparing a habitable world.

To one giving this subject the least attention it is evident that mountain ridges which receive rains and snows, send them by their steep sides, not only to the plains below, but following the rocky slant, far deeper down to the various strata of sands and gravel which were ground, assorted and distributed in that grand old mill of the Glaciers. Repeating this process year by year, as snow, and ice, and rain—brought by the storm and wind, fulfilling His word as the centuries pass—are thus held in reserve, the result is inevitable that all valleys, large and small, ultimately contain measureless stores of water in their lower depths. Thus the physical conditions of valleys, and more especially of mountain valleys, compel them to be water reservoirs, holding such volumes as the materials of the valley debris may determine. Following these relations of cause and effect, it will appear that the mountainous regions of our country, in regard to water resources, may have certain advantages over prairie and plain, whose highest elevations are merely divides at low altitude.

Here, in Great Salt Lake valley, our theory as just given, finds abundant proof. In all directions, for many miles, are thousands of farms, large and small, full freighted with ripening and garnered crops. On the list of grains, or fruits, or roots, nothing desirable or valuable is left out. The rewards of labor or farming are as certain and full as in the Eastern States. Nor is this vast production wholly based upon irrigation. One will see south of Ogden many thousands of acres cultivated by what they term "dry farming," in which only the common rain and snow-fall is used; by fall-plowing and proper seeding, good crops are raised.

Here is the desert of Deseret, now a blooming and fruitful garden, but recently a barren waste. All these prosperous farms and homes came up out of the soil first planted and watered by Brigham Young and his followers on Jordan's peaceful banks, in the summer of 1847. Nor has there been a signal crop failure since that time. No one doubts that this spacious valley can sustain 100,000 more people; yet this is only one of many thousand valleys in the mountains constructed by the same geological agencies and supplied with abundant water from the same unfailing fountains—"ex uno disce omnes." Prompted by this modern miracle, this complete transition from a barren and hopeless desert to a land of plenty, wrought out of human industry, have we not the surest guaranty in the future for the occupation and use of all our domain upon a scale hardly conceivable at present?

Examinations of the soils at intervals on the route, present a general uniformity of composition. In appearance they are lighter towards the west until the foothills are reached, where the soils take on the decided features of glacial drift. In many cases, as one might suppose, these ground and assorted materials are distributed in ledges, extending far down on the plains. While the only hindrance to abundant production is water, it is clear that as we approach the mountains, the soil is more favorable for wheat. Indeed the yield of wheat in Colorado is most remarkable, both for quality and quantity per acre.

It may be suggested, that in the great area occupied by the tertiary formation lying above and west of the cretaceous, and which overlies an extensive region, will be found what may be more appropriately termed "wheat soils." If we seek an explanation of this peculiar fitness, we find in these formations an extra supply of phosphate of lime, which was, doubtless, derived from large and continuous deposits of animal remains, mostly fishes. These remains, in the tertiary beds of the Upper Republican valley, are often thirty feet in thickness, and are equal in fertilizing to the noted marl beds of New Jersey. No one can notice these immense deposits, easily accessible, without perceiving that these rich marls must be distributed by rail over a very extensive country. Had we the lean soils of the Eastern States, the marl traffic would form a leading business.

In confirmation of the vast and undeveloped supplies of water stored within convenient distance of nearly every acre of surface in the great Northwest, we would refer to the thousands of common wells that are reported as unfailing in every valley, or on every plain where human want or convenience has dictated. In scarcely any instance, with powerful pumps, have these wells been diminished. Indeed, so far have we pursued these observations in all the Western States and Territories, that we are prompt to prove this assertion, viz.: That one can scarcely find in the myriads of valleys of the West, even in the region classed by the Public Land Commission as "non-irrigable," or "desert lands"—a quarter-section upon which water cannot be made to flow from a well at a trifling cost. Suppose we admit the cost of a well of average depth, with a windmill of capacity to raise 300 barrels in twenty-four hours, to be $100. Now we say that such a well will bring to the surface sufficient water to (in almost any portion of our unsurveyed public domain) completely saturate or irrigate twenty acres, an area sufficient to supply the wants of any pioneer farmer, or any ranchman or herdsman west of the 100th meridian. If he would irrigate more acres, let him put down another well. The untiring winds do all the work

required; and if the water should be constantly raised day and night, and be poured out upon the ground during both the summer and winter months, it will convince the most skeptical that this great supply, nearest at hand, is sufficient to redeem any of our lands now so falsely classified as "desert lands."

These facts, which are so abundant in our western country, that he who runs may read—the windmill's revolving disc is always in sight—should lead the public to consider that most of our lands in the Western States and Territories can be supplied with abundant water for both stock and agricultural purposes, even if they are situated upon slopes and divides, and far from any stream of water. The absurdity practiced by our government experts is based upon this grave mistake, viz: That there is no water for irrigation except that which can be furnished by a flowing stream, as a creek or river, or by some ditch taken therefrom; and hence they conclude that lands far from these streams on higher levels can never be supplied with water. They appear to have entirely ignored the inexhaustible supply that every man can have for himself upon his own claim or quarter-section at a cost entirely within his means.

The intelligent public will also naturally ask this question, viz: Why beg for these four-section or sixteen-section land grants for artesian wells, when the country is almost universally underlaid with immense sand and gravel beds, affording nearly everywhere these unfailing common wells. For instance, is there no subterranean water on the plains of Eastern Colorado except it be artesian water? On the contrary we know from observation as well as by actual test that hundreds of thousands of good vigorous common wells, with windmills, could be put in successful operation in Eastern Colorado, if necessary, within three months.

Let us first make and use the common fountain-well before undertaking the more costly artesian well fountain. Nor is it in accordance with public policy to patch our great land system with artesian land grants, based upon the common desert reports that have within the past few years emanated from the General Land Office.

In a recent report on the "arid lands" of the West, Major J. W. Powell, of the Public Land Commission, thus disposes of the Territory of Utah:

"In order to determine the amount of irrigable land in Utah it was necessary to determine the areas to which the larger streams can be taken by proper engineering skill, and the amount which the smaller streams can serve. In the latter case it was necessary to determine first the amount of land which a given amount or unit of water would supply, and then the volume of water running in the streams, the product of these factors giving the extent of the irrigable lands. A continuous flow of one cubic foot of water per second was taken as the unit, and after carefnl consideration it was assumed that this unit of water will serve from 80 to 100 acres of land. Usually the computations have been made on the basis of 100 acres. This unit was determined in the most practical way—from the experience of the farmers of Utah, who have been practicing agriculture for the past thirty years. Many of the farmers will not admit that so great a tract can be cultivated by this unit. In the early history of irrigation in this country the lands were oversupplied with water, but experience has shown that irrigation is most successful when the least amount of water is used necessary to a vigorous growth of the crops; that is, a greater yield is obtained by avoiding both scanty and excessive watering; but the tendency to overwater the lands is corrected only by extended experience. A great many of the waterways are so rudely constructed that much waste ensues. As irrigating methods are improved this wastage will be avoided; so in assuming that a cubic foot of water will irrigate from 80 to 100 acres of land it is at the same time assumed that only the necessary amount of water will be used, and that the waterways will eventually be so constructed that the waste now almost universal will be prevented.

"Having determined from the operations of irrigation that one cubic foot per second of water will irrigate from 80 to 100 acres of land when the greatest economy is used, and having determined the volume of water or number of cubic feet per second flowing in the several streams of Utah by the most thorough methods available under the circumstances, it appears that within the Territory, excluding a small portion in the southeastern corner where the survey has not yet been completed, the amount of land which it is possible to redeem by this method is about 2,262 square miles, or 1,447,920 acres. Of course this amount does not lie in a continuous body, but is scattered in small tracts along the water courses. For the purpose of exhibiting their situations a map of the

Territory has been prepared, and will be found accompanying this report, on which the several tracts of irrigable lands have been colored. A glance at this map will show how they are distributed. Excluding that small portion of the Territory in the southeast corner not embraced in the map, Utah has an area of 80,000 square miles, of which 2,262 square miles are irrigable. That is 2.8 per cént. of the lands under consideration can be cultivated by utilizing all the available streams during the irrigating season.

"This statement of facts relating to the irrigable lands of Utah will serve to give a clearer conception of the extent and condition of the irrigable lands throughout the arid region. Such as can be redeemed are scattered along the water courses, and are in general the lowest lands of the several districts to which they belong. In some of the States and Territories the percentage of irrigable land is less than in Utah, in others greater, and it is probable that the percentage in the entire region is somewhat greater than in the territory which we have considered. The arid region is somewhat more than four-tenths of the total area of the United States, and as the agricultural interests of so great an area are dependent upon irrigation, it will be interesting to consider certain questions relating to the economy and practicability of distributing the waters over the land to be redeemed.

"A stranger entering this arid region is apt to conclude that the soils are sterile, because of their chemical composition, but experience demonstrates the fact that all the soils are suitable for agricultural purposes when properly supplied with water. It is true that some of the soils are overcharged with alkaline materials, but these can in time be "washed out." Altogether the fact suggests that far too much attention has heretofore been paid to the chemical constitution of soils and too little to those physical conditions by which moisture and air are supplied to the roots of growing plants."

In the foregoing condensed statement of his views of the productive ability of Utah, Maj. Powell estimates 2 8-10 per cent., or a trifle over one-fortieth of the surface of Utah can be utilized by applying the best methods of irrigation. He also regards this as an average for the entire country within his limits of the so-called arid region. So that, out of the area of Wyoming, Utah, Colorado, New Mexico, Idaho and Montana, containing together 684,782 square miles, there are only 17,120 square miles capable of agriculture.

In rejecting these estimates it is necessary first to compare the amounts of annual rainfall for a term of years for various localities in the arid or desert region, and for this purpose we will refer to the amount of annual rainfall in the most highly cultivated and most productive portions of Europe.

TABLE I—RAINFALL IN EUROPE, ACCORDING TO GUYOT.

Country.	Yearly depth in inches
British Islands	32
Western France	25
Eastern France	22
Sweden	21
Central and North Germany	20
Hungary	17
Eastern Russia, Kasson	14
Northern Portugal	11
Madrid	10

"Paris itself, according to the researches of Arago, has only an average annual rainfall of twenty inches.—(Cosmos, vol. 1, p. 324.)"

"Now it is true that there are many rainy days in Western France (152), and in Central and North Germany (150), yet if we count in the nights when it rains and the days and nights when it snows, there is not so much difference as at first imagined between the wet days of Nebraska and middle and western Europe. Regions in Europe with less rainfall than even western Nebraska, are made successful in agriculture."

TABLE II—RAINFALL WEST OF THE 100TH MERIDIAN, FROM THE SMITHSONIAN RECORDS.

Station.	Height in feet above sea level.	Inches per year	Extent of record. years	mo's.
Albuquerque, New Mexico	5,042	8.11	12	1
Camp Bowie, Arizonia	4,872	15.26	6	2
Camp Douglas, Utah	5,024	18.89	10	3
Camp Grant, Arizonia	4,833	15.08	6	10
Camp Halleck, Nevada	5,790	10.98	5	8
Camp Harney, Oregon		8.76	5	8
Camp Independence, California	4,800	6.70	8	2
Camp McDermott, Nevada	4,700	8.58	6	4

Camp McDowell, Arizona		11.45	8	2
Camp Mohave, Arizona	604	4.66	9	1
Camp Verde, Arizona	4,160	10.85	6	1
Camp Warner, Oregon		14 41	5	8
Camp Whipple, Arizona	5,700	19.28	7	5
Cantonment Burgwin, New Mexico	7,900	8.65	5	9
Drum Barracks, California	32	8.74	5	5
Denver, Colorado	5,250	13.77	5	1
Fort Bayard, New Mexico	4,450	14.32	7	6
Fort Benton, Montana	5,730	33.26	7	1
Fort Bidwell, California	4,680	10.53	8	8
Fort Bliss (El Paso) Texas	3,830	8.63	14	8
Fort Boise, Idaho	1,998	15.48	9	5
Fort Bridger, Wyoming	6,656	8.43	12	10
Fort Buford, Dakota	1,900	11.84	7	10
Fort Colville, Washington	I,953	14.06	11	0
Fort Craig, New Mexico	4,619	11.06	15	9
Fort A. D. Russell, Wyoming		14.09	5	1
Fort Davis, Texas	4,700	17.12	8	11
Fort Defiance, Arizona	6,500	14.21	8	5
Fort Fetterman, Wyoming	4,973	15.10	5	7
Fort Fillmore, New Mexico	3,937	8.24	8	4
Fort F. Steele, Wyo	6,041	15.33	5	5
Fort Garland, Colorado	7,864	15.86	13	1
Fort Lapwai, Idaho	2,000	14.80	9	8
Fort Laramie, Wyoming	4,471	14.45	17	8
Fort Lyon, Colorado	4,000	12.56	7	9
Fort Massachusetts, Colorado	8,365	17.23	5	1
Fort McPherson, Nebraska	3,726	18.96	6	9
Fort McIntosh, Texas	806	17.51	14	7
Fort McRae, New Mexico	4,500	12.59	5	0
Fort Rice, Dakota		21.36	6	1
Fort Sanders, Wyoming	7,161	11.46	6	10
Fort Selden, New Mexico		8.49	8	5
Fort Shaw, Montana	6,000	6.95	7	8
Fort Stanton, New Mexico	5,000	20.94	7	9
Fort Stevenson, Dakota		11.84	6	2
Fort Stockton, Texas	4,950	11.50	5	8
Fort Sully, Dakota	1,672	16.54	7	8
Fort Union, New Mexico	6,670	19.15	17	5
Fort Walla Walla, Washington	800	19.36	8	8

Fort Wingate, New Mexico	6,782	17.42	9	1
Fort Yuma, California	200	3.91	16	6
Salt Lake City, Utah	4,534	24.81	9	1
San Diego, California	150	0.31	24	1
Santa Fe, New Mexico	6,846	14.91	19	10
Pembina, Dakota	767	15.50	4	8
Fort Totten, Dakota	1,480	16.44	5	5
Fort Abercrombie, Dakota		18.78	13	6
Fort Wadsworth, Dakota	1,650	14.15	6	5
Omaha Agency, Nebraska		25.58	5	2
Fort Kearney, Nebraska	2,460	25.22	14	4
Fort Riley, Kansas	1,300	24.62	20	10
Fort Hays, Kansas	2,170	22.70	6	11
Fort Larned, Kansas	1,932	29.42	10	9
Fort Belknap, Texas	5,600	28.05	5	10
*Fort Chadbourne, Texas	2,020	22.88	8	7
*Fort McKavett, Texas	2,060	23.95	9	7
New Braunfels, Texas	720	27.58	5	1
Fort Clark, Texas	1,000	22.61	12	5
Fort Inge, Texas	855	25.46	7	4
Fort Duncan, Texas	1,460	21.33	11	7
Fort Brown, Texas	50	27.88	15	0

It is evident that these amounts are considerably less than the actual precipitation of rain and snow.

If we consider for a moment the rain gauge process of ascertaining the amount of an annual moisture and rainfall, it will appear as a very incomplete and unsatisfactory instrument. Its errors are always against the conclusions sought for. For instance, the atmosphere may be for days heavy with mists and dampness which the earth absorbs. Again, the heavy dews constantly distills during the cool period of each twenty-four hours for more than half of each day, and are also readily received by the dry surface, and eagerly used by vegetable growths.

These considerable amounts are not indicated by the rain gauge. In addition to these we may allow for the loss of the rain gauge by constant evaporation before the record is noted, often several hours after the rain has fallen, especially when storms occur in the night. There goes up constantly from the

earth, now as in earlier ages, "a mist which waters the whole face of the ground.

An allowance of 20 or 25 per cent. should be thus made for the unmeasured moisture which the earth actually receives and which is unnoted by the most careful keeper of the records of precipitation. In addition to these errors an allowance should be made for the large measure of moisture falling in the form of snow, at the time or during driving winds. This amount cannot be correctly estimated. The earth receives the snow but the instrument, except in tranquil periods, fails to properly indicate it.

The annual amount of precipitation for Utah, Wyoming, Colorado, Idaho and Montana may be expressed in cubic feet as follows:

SQUARE MILES.	NO. OF INCHES.	CUBIC FEET.
Utah, 84,476	18	3,532,712,647,600
New Mexico, 121,201,	15	4,223,612,448,000
Wyoming, 97,883,	16	3,508,348,599,000
Colorado, 104,500,	16	4,884,390,040,000
Idaho, 86,294,	16	3,207,651,532,800
Montana, 143,996	16	5,351,532,715,200

The estimate or average, of eighteen inches per annum of snow and rain for Utah; fifteen inches for New Mexico, and sixteen inches for the other districts computed, will not be regarded as excessive; but no one can compare these enormous annual contributions of water to the surface of these regions, with their limited system of creeks and rivers, without arriving at the important conclusions:

1. That the extraordinary evaporation consequent upon this huge yearly blanket of rain and snow must be very favorable to the growth of cereals, independent of irrigation.

2. That the excess of moisture not reached by evaporation nor escaping by the drainage system of creeks or rivers, must abundantly supply the subterranean sand and gravel strata with water for well purposes, in every portion of our unoccupied domain.

During a protracted examination of the territories of Wyoming and Utah, it was everywhere noticed that the grass was

green, not only on the plains but upon the mountain slopes near to their summits. "We have never had so much rain and snow as in the past few years," was a common observation.

In reply to our constant questions in regard to the depth to water, the replies were unvarying, viz., twenty, forty and sometimes sixty feet. In quantity as abundant and in quality as pure, as in any part of the United States.

It is the opinion of all who know these facts, that the fraction of available land accorded to Utah by Major Powell and the Public Land Commission, viz.: two and eight-tenths per cent. or about one-fortieth, is wholly misleading.

It may be a fact, when strictly confined to the possibilities of a mere irrigating ditch, but his inference and intention is to confine the public attention to the puny ditch, as the only means of successful cultivation, and therefore all lands not within reach of living streams in the lowest valley, can even be available for farm or garden purposes. But never was a conclusion more lame and impotent. It is the general verdict of all who have settled in these territories, and whose pursuits enable them to judge of the question of water resources, that land can, with good common wells, be everywhere successfully cultivated, and that with wells, windmills, and the constantly increasing annual rainfall, in addition to the present uses of irrigation, not only Utah and Wyoming, but the adjacent territories, will be utilized for crops, flocks and herds, in the same manner as in other thickly settled mountainous regions, viz.: Spain, France, Switzerland and the New England States.

Of the Rio Grande Valley, in New Mexico, the editor of the Los Vegas Gazette writes:

"One thing is prominently noticeable to the traveller in this valley; there is but a very small proportion of the tillable lands under cultivation. Another fact is equally as patent, that wherever a spot of ground is cultivated and watered it produces abundantly. This is true of the most sandy portions of the valley. What it needs is men, farmers, cultivators of the soil who make that their sole business and source of livelihood. Many persons who visit this section and look at the sandy barren aspect

of the uncultivated lands, without considering the fruitfulness of the cultivated portions, are apt to be disappointed and form adverse opinions of their great value. But this is a great mistake, for experiments, the only true test of anything, prove their unbounded and remarkable fertility.

Thus far, really, only partial experiments in farming, gardening, grape and fruit growing have been made in the valley. The orchards, corn and grain fields, vineyards and gardens, answer satisfactorily as to what these sandy barrens will do when watered and tilled. The land is rich and every inch of it can be cultivated from foot-hill to foot-hill on either hand and through its entire length. The water can be brought in canals from the river, or raised by windmills from a few feet beneath the surface. Let but a population of wine makers and fruit growers from France or Germany go into this valley and possess it, segregate the lands into ten, twenty and forty acre tracts, and plant it to vineyards and orchards, and every foot of the valley will blossom as the vine clad hills of France. A perfectly pure climate free from the moisture which in other countries mildews the grape, will make this valley in the near future one of the greatest wealth-producing regions in the United States. Its possibilities cannot be well estimated or even conjectured."

Referring to the evident proofs of increasing rain, and moisture, Prof. Cyrus Thomas, of Hayden's survey, says:

"All this, it seems to me, must lead to the conclusion that since the Territory (Colorado) has begun to be settled, towns and cities built up, farms cultivated, mines opened, and roads made and travelled, there has been a constant increase of moisture. Be the cause what it may, unless it is assumed that there is a cycle of years through which there is an increase, and that there will be a corresponding decrease, the fact must be admitted upon the accumulated testimony. I, therefore, give it as my firm conviction that this increase is of a permanent nature, and not periodical, and that it has commenced within eight years past, and that it is in some way connected with the settlement of the country, and that as the population increases the moisture will increase."

Lorin Blodgett, whose work on the climatology of the United States is the standard authority in Europe and America, thus describes the regions under consideration:

"The assertion may at first appear unwarranted, but it is demonstrable that an area, not inferior in size to the whole United States east of the Mississippi, now almost wholly unoccupied, lies west of the 98th

Meridian, which is perfectly adapted to the fullest occupation by cultivated nations.

The west and north of Europe are there reproduced, and important as this feature of configuration is in giving us a lofty mountain boundary on the west, may charge much of disadvantage to that account and still have all that is here claimed—an immense and yet unmeasured capacity for occupation and expansion. By reference to the illustrations of the distribution of heat, we see that the cold at the north of the great lakes does not represent the same latitude farther west, and that beyond them the thermal lines rise as high in latitude, in most cases, as at the west of Europe. Central Russia, Germany, the Baltic districts, and the British Islands, are all reproduced in the general structure, though the exceptions here fall against the advantage, where they favor it, through the immediate influence of the Gulf Stream.

The parallel in regard to the advancement of the American States here may be drawn with the period of the earliest Trans-Alpine Roman expansion, when Gaul, Scandinavia, and Britain were regarded as inhospitable regions, fit only for barbaric occupation. The enlightened nations then occupied the latitudes near the Mediterranean, and the richer Northern and Western countries were unopened and unknown."

Suppose, as an illustration, we compare the area of Laramie plains with the area within reach of Laramie river and a few detour ditches that may be taken therefrom for irrigation. The former is one hundred and ten miles in length by twenty to thirty in width; the latter is a mere serpentine strip. Yet we know that the value per acre of this large and beautiful expanse does not depend upon its proximity to the Laramie river.

With artesian and common wells already in use, the water question for the Laramie plains is already settled. Yet there is no difference in the substructure of Laramie plains as compared with any of the expansive and fertile basins, or plains belonging to the drainage system of the Western Territories.

Col. Elliott, of Kansas, a horticulturist of much experience remarks that "there does not seem to be much diminution in the annual rainfall until we get as far as the 103d meridian. Thence to the base of the mountains, the annual average may possibly be two or three inches less than in the midst of the plains, a peculiarity explained by the theory that the region lies to the

westward of the general course of the moister currents of air flowing northwards from the Gulf of Mexico, and is so near the mountains as to lose much of the precipitation that falls upon the plains east and northeast. The mountains seem to exercise an influence, in attracting moisture which is condensed in the cooler regions of their summits, while the plains at their feet may be parched and heated to excess. This explanation may be fanciful, but the fact remains, that near the mountains the rains seem to decrease north of the great divide; but even this occurs in a region where irrigation may be applied extensively, and where there is sufficient moisture to nourish bountiful crops of grass."

"A striking difference exists between the rainfall in New Mexico and that on the plains. While the annual amount at Santa Fe and Fort Hays (100th meridian) is nearly equal, the larger proportion of the rainfall at Fort Hayes comes in spring and summer, while at Santa Fe it is delayed until summer and autumn. Hence the farmer at Hays may have his wheat crop matured in early summer without irrigation.

"The vegetation of the plains along the wagon tracks and railroad embankments, shows a capability of production scarcely suggested where the ground has not been disturbed. Wherever the earth has been plowed or broken, the wild sunflower, and others of the taller-growing plants, though previously unknown in that vicinity, at once spring up, as if spontaneous generation had taken place."

We have seen that the western portion of Kansas, and Southwestern Nebraska are exposed to the warm winds from Arizona and New Mexico. These winds generally unite with the moisture-laden winds from the Gulf of Mexico and give us plentiful showers, but occasionally the winds are dry, and when continued for several days have a serious effect upon corn planted late upon poorly prepared soil.

The liability to these occasional southwest winds of high temperature noticeable annually in July and August, for the areas of Western Kansas, Nebraska, diminishes with the increase of

farming. It is quite certain that cultivated lands, bearing crops of grain, with frequent groves of timber, will in time so modify these winds that they will have no perceptible effect. No disadvantage or damage, however, has resulted from them beyond the occasional interfering with the ripening corn, late planted or planted in a soil poorly prepared. From general experience the farmers are persuaded that both the soil and season demand much earlier periods for seeding than they have been accustomed to in more northern latitudes. These regions are more exposed to warm winds, which, happily are of short duration.

It is impossible to raise sod corn in a dry year, or good corn in any year upon shallow plowing. By as much as there is deficiency of rainfall, or danger of drouth—by so much should there be deep plowing, early planting, and thorough cultivation.

It is, to say the least, a suspicious circumstance that the same commission that made a hurried survey in four months of our government lands, amounting to nearly one billion of acres, should, directly upon the assembling of Congress, have ready a new land law, abrogating all our previous land laws which were the result of seventy years of progressive legislation, seeking to parcel and distribute our domain according to the wants of the people. After nullifying the beneficent provisions of the best system of land laws ever devised, the new scheme proposes to open all the lands unoccupied and unsurveyed in the Western States and Territories, upon a scale of occupation so large that our own homeless population and the foreign emigrant can no longer obtain a foothold upon our inviting plains. And while it is gratifying to know that the last session of Congress did not legalize the iniquitous scheme, yet it behooves all citizens, except the conspirators and partners of this monstrous ring, to watch and protest against its bold demands before the next Congress. Those who during the past year have been observant of the serpentine course of this audacious robbery, in the guise of scientific discovery, should be swift to gather the evidence purposely rejected by the flighty visit of the land commission, in

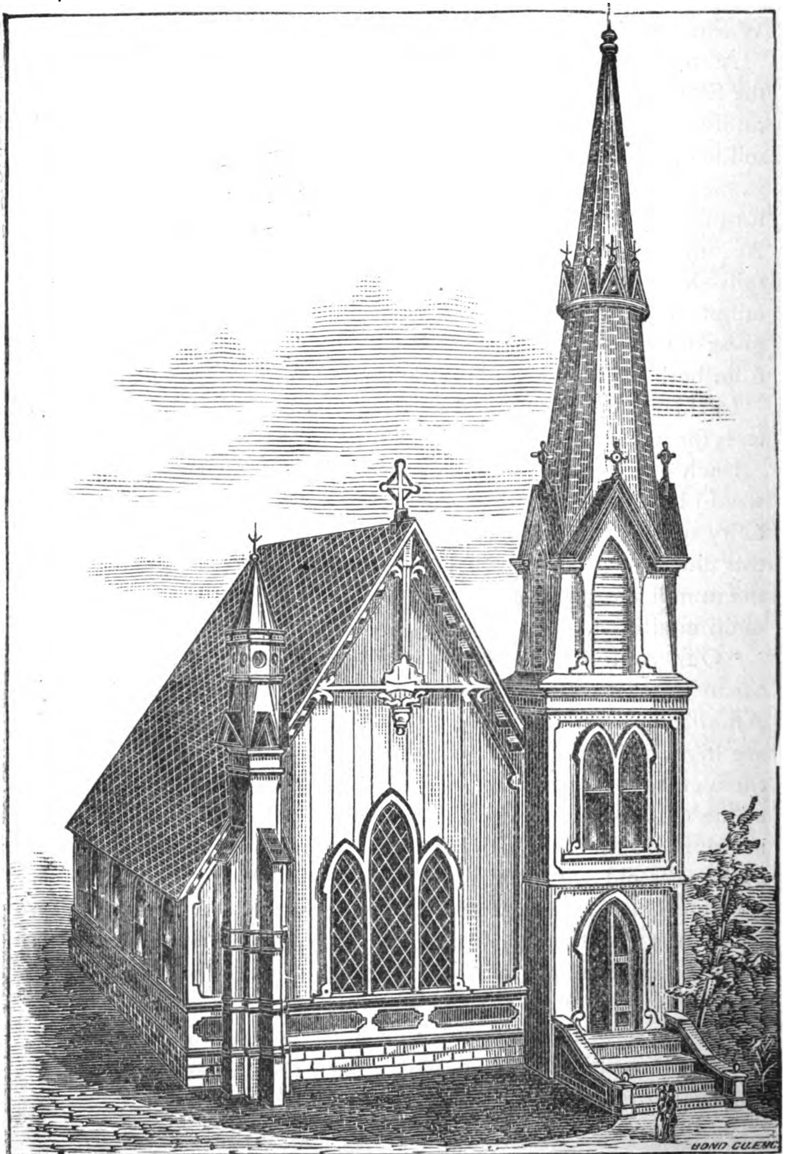
order to bolster an iniquity already agreed upon before they left Washington.

A complete and reliable report upon the area of arable lands of the States and Territories west of the 100th meridian, require a careful survey of all the great valleys of each Territory, giving the soil acreage of each, measured not only along the bottom-lands and terraces, but as far up the inclines on either side as agriculture is usually carried in other productive mountainous regions. Accompanying this report a careful statement of the analyses of soils should be made by competent and reputable chemists, with minute descriptions of such general classes of soils as the progress of the survey discovers, with practical suggestions inferred from both analysis and experiment.

In this report also should be designated the result of numerous tests for water for each considerable area.

Such a report, faithfully rendered and extensively circulated, would be of much more service than mere guesses at the possibility of irrigating ditches in Utah. Until a thorough report of this character is made, the public will readily consent to have the munificent provisions of our present system of land laws remain unaltered.

"Our continent is narrow, and therefore the winds of the ocean water it well. The mountain chains on the east side of the American continent are low; on the east side of the old world, are high. From this results that the trade winds, laden with the wetness of the sea, are attracted to our land. The breadth of the old world and its high eastern ranges causes the rainless interiors of Asia and Africa. Again, America is the land of fertile plains; the old world, of scorched plains. Our plains run north and south, and so attract and receive the rains. America is high under the equator; the old world is wide. Hence with us a small surface is exposed to the scorching sun. The result is that the productive soil of the old world is 10,000,000 square miles and in the new, 11,000,000. This bursts upon us in all the light of scientific truth—the fact that America can sustain a greater population than the entire old world."



PRESBYTERIAN CHURCH—**Beaver City, Furnas Co., Neb., near 100th Meridian.**

THE REAL

THE POET'S DESERT.

"Far in the West there lies a desert land, where the mountains
Lift, through perpetual snows, their lofty and luminous summits.
Down from their jagged, deep ravines, where the gorge, like a gate-way,
Opens a passage rude to the wheels of the emigrant's wagon,
Westward the Oregon flows, and the Walleway and Owyhee.
Eastward, with devious course, among the Wind river mountains,
Through the Sweet-water valley precipitate leaps the Nebraska;
And to the south, from Fontaine-qui-bout and the Spanish sierras,
Fretted with sands and rocks, and swept by the wind of the desert,
Numberless torrents, with ceaseless sound, descend to the ocean,
Like the great chords of a harp, in loud and solemn vibrations.
Spreading between these streams are the wondrous, beautiful prairies,
Billowy bays of grass ever rolling in shadow and sunshine,
Bright with luxuriant clusters of roses and purple amorphas.
Over them wander the buffalo herds, and the elk and the roebuck;
Over them wander the wolves, and herds of riderless horses;
Fires that blast and blight, and winds that are weary with travel;
Over them wander the scattered tribes of Ishmael's children,
Staining the desert with blood; and above their terrible war-trails
Circles and sails aloft, on pinions majestic, the vulture,
Like the implacable soul of a chieftain slaughtered in battle,
By invisi stairs ascending and scaling the heavens,
Here and there rise smokes from the camps of these savage marauders;
Here and there rise groves from the margins of swift-running rivers;
And the grim, taciturn bear, the anchorite monk of the desert,
Climbs down their dark ravines to dig for roots by the brook-side,
And over all is the sky, the clear and crystalline heaven,
Like the protecting hand of God inverted above them."

—*Longfellow's Evangeline*.

THE IDEAL.

CORRESPONDENCE.

BROWNSVILLE, NEB., December 8, 1879.

Profs. Samuel Aughey and C. D. Wilber:

Sirs:—As citizens of Nebraska in common, feeling deep interest in all that concerns its welfare, development, and prosperity; also acting in the capacity of representatives of organizations having in view the objects named, we note with anxiety, movements tending to "condemn as agricultural," and denominate, *for all time to come*, only as "pasturage lands," that portion of the State situate west of the one-hundreth meridian. Knowing you both as many years residents, engaged in scientific pursuits and labors, and as having given extended, minute personal attention and study of the geography and natural characteristics of the region indicated, will you be pleased to favor us, in such elaborate and scientific form as time and circumstances may permit, such facts as you have at command bearing upon the points named.

Very truly yours, etc.,

ROBERT W. FURNAS,
Prest. Nebraska State Horticultural Society.
MARTIN DUNHAM.
President State Agricultural Society

UNIVERSITY OF NEBRASKA,
Lincoln, Neb, Feb. 8, 1880.

Hon. Robert W. Furnas, Prest. Nebraska State Horticultural Society, and Martin Dunham, Prest. State Agricultural Society:

DEAR SIRS:—In answer to yours of December 8th, we reply as follows: It appears that a congressional committee has been engaged during the last year in a so-called examination of the unsettled lands west of the one-hundreth meridian. It is stated upon high authority that in the forthcoming report of this committee it will be recommended that all these lands, or at least the greater part of them, be withdrawn from the operations of pre-emption, timber claim and homestead laws, on the ground that they are only fit for pastoral purposes. We wish first to direct attention to

THE CHARACTER OF THEIR EVIDENCE.

So far as we can learn, no chemist of any note went with the party. Their mass of evidence, which, as they indicate, will take four or five months to arrange and condense, is the opinion of many settlers, men of the plains, ranchemen and herders. This class will constantly repeat the old assertion, which is that the country is dry and always will be dry.

We present these statements, based on repeated experiments and observations during the last twenty years: That the soil of the Western States and Territories beyond the one-hundreth meridian in Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Utah, Nevada, Oregon, Washington Territory and California, is chemically equal to any similar area of soil taken in any part of the American continent.

We state, secondly, that its only lack is, in some portions of this region, water; and that it does not lack any quality or ingredient of soil necessary to the ample production of the farmer's and gardener's desired crops.

We further state that this general and uniform character of good soil is the result of the decomposition of primary rocks, old sea deposits and glacial agencies acting through long ages over great areas of both mountains and plains, and that the result or soil could not be other than to a large extent comparatively homogeneous.

We will not here go into the argument with comparative analyses. But nothing can be plainer to the Public Land Commission, and we are certain that analyses will show everywhere in these great areas that the soils are chemically and mechanically approximately the same for mountain areas and foot hills: being only the results of glacial grinding and distribution, while all over the plains are spread the vast deposits of the great crustaceous seas and tertiary lakes, that contributed by their decomposition and erosion to the loess formation.

The only practical question, therefore, after settling the character of these soils by analyses, is the one connected with the supply of moisture. It is asserted that the rainfall beyond the one-hundreth meridian is not sufficient for the cultivation of cereal grains, corn, root crops and fruit. To this it may be replied:

1. That while this may be the case in portions of this territory in Colorado, Wyoming, Utah, etc.,the present rate of increase in rainfall to be considered further on, will in a comparatively short time fit these regions for agriculture without the aid of irrigation. In the eastern portion of this region which it is proposed condemn the rainfall even now is sufficient for agricultural purposes. For example in Furnas, Red Willow and Hitchcock counties, in the Republican Valley, and in Frontier, Gosper, and other counties, the production of corn and grain is not only possible, but has, by actual experience during the last few years been proved to be successful and profitable.

The actual rainfall in a portion of this region, and especially in western Nebraska, as deduced from a great number of observations by individuals and the signal service, shows that the average annual rainfall

of twenty-six inches reaches almost to North Platte, and that beyond that point in western Nebraska, at least, the annual rainfall amounts to at least, from sixteen to seventeen inches. As a large amount of this rainfall occurs in early summer, at the time when crops most need moisture, it is clear, as has also been proved by experience, that the rainfall, with proper cultivation, is sufficient to produce successfully root crops, fruit, corn and the cereal grains. This is the more apparent when we compare the rainfall here with that of favored localities in Europe. No one thinks of relegating to mere pastoral use that part of Portugal on the borders of her table land, where the rainfall is only eleven inches a year. The plains of Castile, so famous in history, only receive a rainfall of ten inches. Even Lisbon is watered by only twenty-seven inches of annual rainfall. Central and North Germany enjoy no more annual rainfall than North Platte, of twenty inches. The annual rainfall of Hungary is seventeen inches, or two inches less than western Nebraska. And yet, because of the excellency of the cultivation of the soil there practiced, dense populations are supported by the products of the land. The rainfall in eastern France amounts annually to only twenty-two inches. (Guyot's Earth and Man, page 162.) Comparing, therefore, western Nebraska with some of the most highly favored sections of Europe, it is seen that it possesses at least the same amount and advantages of rainfall.

3. It has not been sufficiently observed that the growth of nutritious grasses is in itself proof of a fertile and agriculturally rich region. The Buffalo grass, it is admitted, always flourished on our western plains. Almost as soon as the buffalo grass retreated other grasses, taller and more useful, rapidly took its place. The grasses belong to the same family of plants as the cereal grains. Where the former spontaneously flourishes the latter can, by careful culture, almost everywhere be made to grow. The richness of a region is also indicated by the variety of its spontaneous productions. In this respect western Nebraska and the contiguous regions are remarkable. The floras of these regions already published indicate that vegetable forms are prolific in the numbers of individuals and species.

4. We hold, moreover, that the moisture and rainfall is gradually increasing from east to west, by the constant operation of laws and forces that will certainly accelerate until the great areas before mentioned have their plenum, as in the States east of the Missouri river.

We base our argument for gradual and complete grass and grain growth on the major part of the lands of the U. S. domain excepting actual rocky areas: First, upon a large number of actual analyses in all the

eastern territories of this region; second, upon the westward march of grass and grain growths of the Missouri river to the western limit of Nebraska, especially in the Republican Valley, a distance of 350 miles. The old settlers in Nebraska all remember that twenty years ago it was said that wheat could not be grown on the uplands. When the uplands were found to produce even better wheat, in some seasons, than the river bottoms it was said that this could only occur in the eastern part of the State, near the Missouri. The testimony of early explorers was against it. Finally the boundary was fixed at the one-hundreth meridian, beyond which grain could not be successfully produced. Now it is produced at least one-hundred miles beyond this point, without irrigation, and another imaginary line is sought after, but even the experts are at a loss where to find it. Third, it is clear that rainfall is and has been increasing from year to year. The tables elsewhere published in your report of rainfall in the past and present in Nebraska, are abundant proof of this assertion. Whatever may be the cause of it—and this our space does not permit us to discuss—the rainfall is clearly increasing from year to year. It is also indicated by the disappearance of vegetable forms, characteristic of dry, and the introduction of species native to moist regions. It is proved by the appearance of springs all over the State where they were not known before. It is also evident from the past that hundreds of old stream beds, that have disappeared and had become grown over with grasses and sod, have again resumed their ancient character, and are, partially at least, now during the year filled with water. Many other facts, which our space does not permit us to mention, could be adduced, all showing a constantly increasing rainfall all over the State. As pioneers take up the government lands and encroach on the plains the line of abundant rainfall also marches westward.

Admissions of scientific men, point to the same conclusion. Thus Clarence King, the present chief of the United States geological surveys, remarks (Systematic Geology of the 40th Parallel, page 525) in reference to Great Salt Lake: "I have already shown that between the period of the Stansbury survey and that of my own there was an increment of 600 square miles in the area of the lake, and a rise of eleven feet." * "The cyle of moisture which has recorded itself in the increased volume of Salt Lake is also evident in many other localities and in different ways. Mono and Owen lakes, at the east base of the Sierras, show a corresponding rise, and, as has been stated before, all the residual lakes in the basin of Lake Lahontan evince the same change." * * * "Since the late cycle of increased moisture in the winter accumulation of snow on the Sierra summit is evidently greater than since the earliest growth of the

present forest." * * "From these facts it would appear that the existing climatic oscillation began before the year 1870, and was the first of its kind for over 270 years. The year 1866 is about the date of the increase of Salt Lake. Mono lake shows a rise in 1864, and the destructive Sierra avalanches began about 1860," caused by the increase of snow.

It is remarkable that in studying the history of the quarternary age that all over the regions of the plains and the mountains there were long periods of very great humidity, followed by epochs of dryness like the one through which we have just passed, followed again by periods of moisture. These periods lasted for many tens of thousands of years. It is not impossible that we are entering on another moist period, the length of which, especially when aided by the causes that man sets in operation, will be beyond all calculation.

Observation, experiment, and the highest scientific authority demonstrate that climates in the West are becoming moister; that rainfall is increasing steadily. This increase must extend until the plains east of Denver and Laramie receive sufficient rainfall to produce farm products with irrigation.

For these reasons we are compelled to say that any evidence of present dryness, where dryness exists, is evidence only for the present, and should not be used to cover these areas with the undeserved reproach or curse of desert lands.

It follows also that the evidence of any number of ignorant persons, whether merchants or herders, is wholly incompetent on this question, and should have had no weight before a Congressional committee.

The alienation therefore of 500,000,000 to 800,000,000 acres of these vast fertile areas that are surely changing their dry character to answer the farmers' varied uses and demands—and by law maintaining them as vast pastures or commons, when they could, in tbe near future, be fruitful farms—this would be a fearful robbery, and those who are conspirators in the attempt should receive public execration.

This policy which is now proposed, and which would stop the operations of the present land laws, which have been perfected by three-fourths of a century of agitation and legislation, would be in the interest of the few against the many—in the interest of capital against the toiling millions. The success of this project would be a crime against society and calamitous to us as a State.

Respectfully submitted,

SAMUEL AUGHEY,
C. D. WILBER.

CHAPTER IX.

GEOLOGY OF THE FORTIETH PARALLEL.

The Geological System of Nebraska begins with: 1st, The Upper Carboniferous Formation; 2d, The Permian; 3d, The Cretaceous; 4th, Tertiary; 5th, The Quaternary, and 6th, The Alluvium — The Coal Measures of Nebraska — Report of Recent Tests.

IT will be interesting as well as practical, to know the basis or rocky foundations of the extensive regions whose surface description in this volume has already occupied so much space.

Starting from the Missouri river, and moving westward on the line of the 40th parallel to the Rocky Mountains, we gradually ascend a great incline of valleys and plains, most resembling the slope of a house roof. In studying the subjacent geological formations, the comparison is yet more forcible, if we compare the successive outcrops to the recurring courses of shingles upon a roof, until we reach the ridge, or summit.

Let us draw a straight line from the southeast corner of Nebraska directly west, in the proportional ascent of seven feet per mile, and upon it note the spaces occupied by these several divisions in their proper order. The principal formations are, first, Upper Carboniferous; second, Permian; third, Cretaceous; fourth, Tertiary; fifth, Quaternary, and sixth, Alluvium. The Upper Carboniferous—the lowest in the Nebraska series—occupies the region from the mouth of the Nemaha to the Otoe Agency. The Permian occupies the area between the Otoe Agency and Steele City. The Cretaceous lies between Steele City and Republican City, or mouth of the Prairie Dog, near Republican City; and the Tertiary and Cretaceous comprises the entire region west and beyond the limits of Nebraska.

Along the eastern base of the Rocky Mountains, the divisions between the Cretaceous and Tertiary formations, has not as yet

been definitely determined. Geologists with strong Tertiary tendencies, are at variance with the Cretaceous group of naturalists, and pending this literary litigation each may indulge his fancy.

In this chapter we will endeavor to present the reader with a practical view of the geological structure of both Southern Nebraska, and Northern Kansas, such as can be obtained in a brief survey of the successive formations as they appear to an intelligent observer. At the outset it should be understood on this line that which is geographically lowest is also lowest down in the geological scale—beginning with the Upper Carboniferous, which is common to Southeastern Nebraska and Northeastern Kansas. Add to this, that the successive geological formations are like the overlapping courses of shingles in ascending a house roof, and the reader is prepared to make an accurate survey of the adjacent counties in either State along this noted parallel. The remark may not be needed, but it should be borne in mind that this description of the proposed line refers only to the successive series of rock formations, and not to any materials that may have been imposed upon them, such as drift beds, glacial clays and gravel soils, etc., which are usually classified as Quaternary and Alluvium deposits.

The Upper Carboniferous extends from the mouth of the Nemaha river through Richardson and Pawnee counties to a point near the Big Blue river—a distance of 70 miles. Allowing ten or fifteen miles for the undetermined range of Permo-Carboniferous, we must give to the Permian formation a space of 15 miles, extending from the meridian of Beatrice, west to Steele City.

The Cretaceous formation extends from Steele City west, through Jefferson, Thayer, Nuckolls, Webster, and Franklin, to Alma, the county seat of Harlan county—a distance of 120 miles.

The disputed territory of the Tertiary occupies all the region west of Cretaceous, to, and beyond the Colorado line. In this

geological district will be found Harlan (western half), Furnas, Red Willow, Hitchcock, and Dundy counties, with the corresponding in Kansas, viz.: Phillips, Norton, Decatur, Rawlins, and Cheyenne. It also comprises the area of the plains (as far as the foothills), or more definitely ,as far as that irregular line, where, by upcast, the same formations have been made to appear at the surface in the vicinity of the Rocky range.

In those far western regions, notwithstanding so many exploring expeditions, as before remarked, little has as yet been definitely settled in regard to limits of either the Cretaceous, or Tertiary formations.

The supply of coal within the limits of Nebraska, still engages public attention more than any other topic relating to our natural resources. Coal has so often been announced in nearly every county in the State, by local journals, without any practical results, that the public, by tacit consent, receive with grave doubts all statements on this subject.

By a careful examination of the upper Coal Measures, in S. E. Nebraska, the thickest vein discovered does not exceed thirty inches, and it is not reliable for more than twenty four inches in thickness.

Of this only a portion—the upper half—can be utilized, its lower portion being largely mixed with combinations of iron and sulphur. These coals in both southeastern Nebraska and in northeastern Kansas, are quite generally used by the farming population, but are not mined and distributed in the general trade. This vein, varying in thickness from thirty inches to ten inches, finally disappears and is not anywhere seen west of the Big Blue river. From this circumstance it has been inferred that the upper Coal Measures have gradually thinned, from Iowa and Missouri, and therefore present no workable vein in Nebraska. It should be, to avoid any misdirection, distinctly understood that the limited areas of coal occurring in Republic county, Kansas, also in Thayer and Jefferson counties, Nebraska, are not portions of the Iowa or Missouri system of Coal Measures. On the

contrary they belong to the Cretacous System, wich is fully developed along the base of the Rocky Mountains, but which occasionally exhibits small outliers or basins in various localities. In some instances these have been developed into a local supply, but do not encourage any outlay of capital for mining operations.

The question that constantly occurs is this: What are the prospects for coal at any depth below the surface? Will the middle and lower Coal Measures afford coal in paying quantities? To this the reply comes, from a few deep tests that have been made at Lincoln, Omaha and Beatrice, from 750 to 1200 feet, that the middle Coal Measures are also deficient in coal veins of suitable thickness for mining operations. What may yet be found, at still greater depth, is vague and indefinite. The Leavenworth vein—thirty inches thick at a depth of 710 feet—would not be found in Nebraska at a depth of less than 1100 feet. Nor is it probable that, when found, its thickness would be increased. It hasnever been a profitable investment, considering the great cost of the shaft.

The White Breast coal vein, near Chariton, Iowa, at a depth of 500 feet, should be found at the Missouri river at a less depth than 750 feet, but no trace of it was discovered in boring the artesian well at Omaha to that depth.

At many points, in the Republican Valley, are thin seams of coal, often less than one inch in thickness, with a general increase toward the west. Judged by their structure these are lignites. When recently found they show the usual effect of imaginary bonanzas, (for particulars see county papers.) This is generally heightened by some person who claims to be a mining expert, and after the community has enjoyed a brief inflation the usual order of things is re-established.

On the divides of the Beaver, beyond the Republican river, in the direction of Denver, are several strata of cretaceous coal, with a thickness of from three to four feet, These are loose and spongy in texture, as if the work of carbouizing and compressing

were both imperfectly done. Also just beyond the divide, toward the Big Sandy, in the direction of Godfrey station, K. P. R. R., the same coal formation attains a thickness of 6 to 7 feet. It is found in great abundance, and can be cheaply mined either by short shafts or drifts. It will serve all ordinary uses, but will always be considered inferior to the more compact and brilliant coals that are found nearer the mountains.

It is evident, after several years of careful exploration, that the seams of coal for use and distribution, in both western Nebraska and Kansas, must be derived from the extensive cretaceous deposits already referred to. They are already mined on a large scale for rail road uses, and are shipped as far east as Omaha and Lincoln. For steam and domestic use, they are equal to bituminous coals from the eastern or carboniferous formations. Only a few outcrops have as yet been developed—at Boulder, Marshall, Golden, Colorado Springs, Trinidad, Rock Springs, Evanston, etc., but from these localities it is evident that the supply is practically unlimited.

Coal is the most valuable of all the kinds of fuel, because it contains the greatest amount of heat in the smallest space. It is found in nature, ready made, kindles at a touch, and yields its wonderful treasures of heat without cost. In our day the extraordinary value of coal as fuel has been reached, from its cheap and instant power to generate steam, which is now doing or performing the general drudgery of mankind. It is estimated that the aggregate power of steam engines now in use, sustained by coal, in all countries, is equal to the combined muscular energies of 1,000,000,000 of men, or that the present activity of steam is equal to the muscular strength of the entire human race, who are entirely willing to have King Coal furnish this all-potent energy of steam to form and fashion, spin and weave, dig down mountains, fill up valleys, cook our food, do the washing, carry us abroad around the world and bring us safe home again; in short, do anything, except voting.

The distribution of coal is therefore a subject of the greatest importance in any inventory of materials on which to base our national prosperity, and consequently we find that there is more active search now made for coal in the various countries of the globe than for gold, silver or precious stones.

We read that Solomon, who knew everything, challenged nature to reveal to him the true wisdom, or riches. But where shall true wisdom be found? said he. "It is not in me," said Gold and Silver," "and not in me," said the diamond." But in our day of miracles, as wrought by the manifold uses of coal, Solomon would have said that the wisdom of the Creator can not anywhere be so clearly seen as in the adaptation of the thousand uses of coal to the wants of man. Its gradations of heat are so nicely adjusted that its least service renders "December as pleasant as May." Upon further entreaty it reduces the metals to a fluid state. At 4,000° Fahrenheit the melting point of iron is reached. In the Argand burner, with coal gas, 11,000° Fahrenheit is attained, which subdues nearly all earthly substances, and gives man dominion over the entire mineral kingdom. Coal is therefore king—crowned with the common consent of every human industry. It turns night into day in all our cities, so that there is no night except of our own choice. All streets and stores are golden with it, and every dwelling has an effulgent beauty within which disappears with the rising of the sun; and when the true millenium comes it will take its rise from a drop of water touched into activity by the magic scepter of King Coal.

It is no wonder then that civilized nations are very vigilant in searching the earth for the purpose of finding new coal deposits. In an examination of the northern and western States and Territories during the past fifteen years, on this very errand, I have met scores of geologists, English, French, Prussian, Dutch, Austrian and American, looking for our placers of black diamonds, and quietly investing millions of dollars—exchanging gold for coal.

In this search, which has been very intelligent and minute for the past thirty years, every part of the habitable globe has been examined. In the United States we have special reasons for determining our coal area. The railroad kings want to know, because coal deposits determine the direction of the railways. Uncle Samuel wants to know, for he sets a reward of $10 per acre upon all coal lands. The capitalist wants to know, because the value of lands is enhanced 1,000 per cent. if underlaid with a workable vein of coal in a favorable location. The real estate speculator wants to know, for obvious reasons; and so great is the eagerness for coal lands that frauds and misstatements are most common. A local newspaper can start a coal mine on short notice, and a sham geologist can be bought for a small sum of money.

The great American coal fields are well known.

1. The Apallachian coal fields contain 200,000 square miles, and include Pennsylvania, Eastern Ohio and Kentucky, Western Virginia, Northern Alabama and Northwestern Georgia.

2. The Illinois coal fields contain 50,000 square miles; 35,000 in Illinois, 6,000 in Indiana and 9,000 in Western Kentucky.

3. The Iowa and Missouri coal fields were estimated by D. D. Owen, the father of American geology, to contain 55,000 square miles.

(The Kansas and Nebraska coal field is separated by the Missouri river, and should be considered as the western part of the same system of coal measures.)

4. The great Colorado coal field contains over 300,000 square miles, and is the largest coal field in the world. It extends from New Mexico on the south, through Eastern Colorado, Utah, Wyoming and Montana, far north into the British Possessions. Its existence was hardly known ten years ago. It has been and is now the subject of national and special surveys, made in the interests of government, railroad companies and capitalists, as already stated. Its discovery and development gives the world an assurance of a new empire, whose riches

shall far outshine "the wealth of Ormus or of Ind"—a new realm of mineral resources, whose grandeur, unfolding for a thousand years, can be only dimly seen in the light of to-day. Every trans-continental railway will pass directly through it and carry its pure coals and rich ores, not only to the towns and markets of the Pacific slope, but also to the fertile plains of the Missouri river and her splendid system of valleys. It is the Eldorado of our future history.

We have seen that Southeastern Nebraska is included in the coal measures as Western Iowa. We shall now inquire what are the practical facts pertaining to these coal measures, and what are prospects for coal in Nebraska. While the coalfield, or coal measures of Iowa include the entire area of the Carboniferous formation, according to Owen, we find upon close examination that the area of land containing workable coal is exceedingly limited. Thus after a most careful and costly examination, the really valuable coal measures of Iowa dwindle down to a single basin, extending northwest and southeast in the valley of the Des Moines river, not over 150 miles in length and fifty miles in breadth; and in Missouri the principal coal basin yielding coal for use, lies north and south in the valley of the Charitan river, extending north into Iowa, and does not exceed 130 miles in length by thirty in width.

The Iowa and Missouri area of coal surface available for mining, instead of being 55,000 square miles is less than 12,000 square miles. This result has been deduced from an extensive series of borings, or test wells, on the line of every railroad, both in Iowa and Missouri, viz.: B. & M. R. R., C. R. I. & P. R. R., C. & N. W. R. R., and Dubuque & Sioux City R. R., in Iowa; also, along the entire line of the H. & St. Joe R. R., St. Louis & Kansas City R. R., Missouri Pacific R. R., Atlantic & Pacific R. R., and M. K. & T. R. R., in Missouri. About 100 tests, or borings, were made at depths, varying from 500 to 1,500 feet. They were put down at a cost of over $150,000. The result may be stated as follows:

In Western Iowa and Northwestern Missouri, all the coal seams found at these depths are too thin to be of any practical value. As many as ten seams have been passed through in these deep borings, but in no instance has a workable vein or seam of coal been reached in the vast area above described. West of the Missouri river, both in Nebraska and Kansas, the search has been equally severe along the following lines of railroad: On the Kansas Pacific, between Kansas City and Denver; the M. R. F. S. & G. R. R., L. L. & G. R. R., St. Joe & Denver, Atchison & Nebraska R. R., B. & M. in Nebraska, U. P. R. R., Missouri Pacific, between Atchison and Kansas City, and A. T. & S. F. R. R. In all these borings, deep or shallow, we find invariably thin coal veins from four inches to twenty-five inches in thickness. In one instance at Leavenworth a coal shaft was put down to the depth of 710 feet, because the State geologist, Prof. Swallow, assured the citizens from a boring that a thick vein of coal would be reached. The boring, or test well report showed "nine feet of coal and slate," which the citizens interpreted as at least seven feet of good coal. After expending $100,000, twenty-five inches of coal was found. The cost of mining at this depth is greater than the price of coal; so that the foolish expenditure is a public loss, from which wiser counsels might have saved them.

In the test well at Lincoln, 900 feet was reached, and a vein of coal four feet and nine inches thick was reported at a depth of nearly 500 feet. There was no special pains taken to save all the chips, or bits of coal made by the drills; no careful measure taken either on striking or leaving a vein, (?) and no discrimination to ascertain whether the chips were all coal, or both coal and slate. The results of the Lincoln experiment are therefore vague and uncertain, and the citizens have but little faith in the reported coal vein. If they believe the report a shaft would have been completed before this date. The boring at Beatrice reached a depth of nearly 1,300 feet. At Lincoln the Leavenworth vein should have been reached at a depth of 1,100 feet;

and at Beatrice, at a depth of 1,200 or 1,300 feet, judging from the depth of the several veins of the coal measure taken in connection with the topography of the country.

Other deep borings have been made in the State, and they uniformly point to the same conclusion, viz.: there are no workablé veins of coal at all depths from the surface in Eastern and Southeastern Nebraska.

To this general statement may be excepted the recently reported test or boring at Ponca, Neb., which, however, for various reasons, should be confirmed by other tests upon large areas.

Passing by the Leavenworth mine we find at Kansas City, a test well near the city. It passes through the same series of thin veins, one of them being thicker than the others but not workable. At Fort Scott, and several points on the M. R., Ft. Scott & Gulf R. R., deep soundings were also made. At the last-named place the borings passed through eleven veins, varying from four to twenty-four inches, all equally worthless.

At Lawrence, Topeka, and as far west as Junction City, depths have been reached from 500 to 900 feet, with the same cheerless returns, viz.: no workable coal at any depth below the surface. These facts are much at variance with Prof. Swallow's eloquent statement that "Kansas is underlaid with an immense coal vein seven feet in thickness, and contains one-seventh of all the coal in the United States." (See Swallow's Report—Geology of Kansas, 1864).

It is noticeable in the deep soundings above described, that the coal strata invariably decrease in thickness going west from the Missouri river, and we may safely conclude that every vestige of the old coal measures has entirely disappeared before we reach the western boundary of Kansas or Nebraska.

There is not an outcrop of the old coal measures in any of the Territories west of these to States, nor are they exposed anywhere in the rude breaks, or upcasts of the Rocky mountains.

The upper, or surface vein of coal, in Nebraska and Kansas has a variable thickness, and occupies a large area in

each of the four States, viz.: Southeast Nebraska, Southwest Iowa, Northwest Missouri, and Northeast Kansas. It has many outcrops, as it lies near the surface and is cut by ravines, by which means we have been able to determine its value accurately. In the vicinity of White Cloud, Kansas, and Rulo and Falls City, Nebraska, and on the Iowa Reservation, and the lower portion of the great Nemaha Valley, it attains the greatest thickness, varying from ten to twenty-seven inches, but it does not average eighteen inches. The "Richardson county coal" is a part of this coal seam, and it measures from seventeen to twenty-four inches in drifts and cuttings near the Nemaha river; of this only eight to ten inches is good fuel, the lower part of the vein being very sulphurous, and unfit for use. It will probably never be mined except to supply a local demand among farmers and towns in the vicinity of outcrops of more than average thickness. At Tecumseh, this vein has thinned out to less than ten inches, and has almost, if not entirely disappeared before reaching the valley of the Big Blue river. But it appears to have a greater range north and south. It is found north and northwest of Omaha, and in all the river counties of Southeast Nebraska and Kansas. All statements, however, such as have been made concerning this vein "that it will increase to four or four and one-half feet in drift-mining" are simply and only efforts of pure imagination by some; pure fiction by others. Seeing that the upper, or surface vein has neither thickness, quality, nor reliability, and that all the lower veins are uniformly thin and useless, we anxiously inquire what, and where, are the resources of fuel for the State of Nebraska? Until we have thoroughly tested the middle and lower coal measures, we have no encouragement to give for a workable coal vein in Nebraska. The people of Western Iowa and Northeastern Kansas have the same concern in this question. It is very desirable to please the people and gain the applause of our fellow citizens, but it is exceedingly difficult to do this by making a coal mine in every county. The only practical road out of these difficulties is either to probe

deeper, or to make timely arrangements to procure our coal from places where it is both cheap and of good quality.

The present supply of coal for Eastern Nebraska comes mainly from mines in the Des Moines Valley; also from mines in the valley of the Chariton river, Mo.; and from mines in Southeastern Kansas, in the vicinity of Fort Scott. A large amount is also distributed in Nebraska from the Wyoming mines reached by the Union Pacific Railway. These coals differ but little in ability to produce heat or steam. A ton of these coals is equal to three cords of such wood as we find growing west of the Missouri river. Coal at eight dollars per ton in Nebraska, establishes the price of wood, as fuel, at two dollars and sixty-six cents per cord. If some persons more remote give nine dollars a ton for coal, it is only giving three dollars per cord for wood. Those, therefore, who complain of a scarcity of fuel in Nebraska, can only complain that wood is three dollars per cord. The policy of railroad companies, in regard to coal freights, should be especially low; so that anywhere in Eastern Nebraska coal can be afforded at six dollars per ton—the equivalent of wood fuel at two dollars per cord. Upon this basis, we have fuel from Eastern and Southern mines both cheap and abundant. The great fault appears to be that it is not mined beneath the soil of Nebraska.

A family of five persons will consume an average of five tons annually, costing from $35 to $45. This would require the proceeds of three acres of wheat, or five acres of corn, or the price of a colt, or a three-year-old steer. Is the fuel bill for a year really a burden to any farmer in Nebraska? With equal reason we could complain of the cost of clothing; which is the same as saying that we would greatly prosper if we could dispense with clothing altogether. We respectfully refer the fuel-faultfinders to a residence with some of the Indian tribes, whose habits and fashions make their burdens easy, in this respect.

The comparative value of mineral fuel, or coal, and vegetable fuel (wood, and corn,) may be interesting to farmers who

are now trying experiments with the various kinds of fuel in Nebraska, and other Western States, where coal and timber are not abundant. The best experiments gave the following results: An average cornstalk and one ear will yield six ounces combustible matter.

One ton cornstalks and ears yields 450 lbs. combustible matter.

One ton sunflowers yields 650 lbs.

One cord cottonwood, 600 lbs.

One ton coal, 1,700 lbs.

The unexplored sources of coal in Nebraska, besides the lower coal measures, are the Tertiary, Cretaceous, and Permian formations, occupying the middle and western portions of the State. The Permian formation has been found by Prof. Aughey, of the State University, to occupy a considerable portion of Eastern Nebraska, immediately overlying the receding coal measures, as already described. It is probable that this formation will be found to contain useful veins of lignite, or brown coal. The Cretaceous and Tertiary formations lie further west, and outcrop, as stated before, like courses of shingles as we ascend a house roof. These formations contain a series of valuable coals, comprising the great Colorado coal field which we have briefly described.

In Kansas, on the K. P. R. R., near Fort Harker, or Ellsworth Station, 225 miles west of Kansas City, two veins were found, two and one-half and three and one-half feet in thickness. In Nebraska, partial examinations have been made in the valley of the Republican and several outcrops have been found, indicating that we may find both veins upon careful search. It is evident that they will be found much farther east in Nebraska than in Kansas, because the trend, or direction of these coal-bearing rocks is toward the northeast. The most natural supply of good coal, for a very large portion of Nebraska is, or rather should be, the great deposits of coal, or lignite; the first reached on the Union Pacific, about 600 miles west of Omaha. These deposits consist of eleven veins; five of which are workable, varying in

thickness from six to twenty-seven feet. Their outcrops are cut by the U. P. R. R. at intervals for 500 miles. This coal is very easily mined.

Concerning the recent discovery of coal at Ponca, Dixon county, Neb., Prof. Aughey makes the following condensed statements in a letter to the Omaha Daily *Republican*, of Dec. 6th, 1880:

1. The coal was struck at a depth of 570 feet, and is four and a half feet thick. The analysis of a specimen which I brought home with me shows it to be most nearly allied to the coal found at and near Des Moines, Iowa. It is a bituminous, cokeing variety, and compares favorably in quality with the average coals found in that district.

2. The Ponca coal is found in the lower carboniferous measures. These deposits are overlaid by the upper carboniferous beds, and these in turn by the cretaceous. The upper carboniferous rocks are mainly barren, and their varying thickness is the cause of the great depth at which the true coal measures are found in different parts of the State. Broadhead's geological survey of Missouri demonstrated that the upper carboniferous Measures are in that State 2,000 feet thick. Towards the Nebraska line they are considerably thinner. Hayden, Meek and White have shown that at Nebraska City these upper carboniferous beds are proximately 1,000 feet thick. (See Hayden's final report, 1870.) I have shown elsewhere (Physical Geography and Geology of Nebraska) that at Plattsmouth their thickness is below 900 feet (I now think it must be near 875 feet.) At that rate the depth of the true coal beds at Ponca should be about 600 feet. Actually, they were found to be at 570 feet. In general, therefore, it may be stated that the farther the true coal beds are looked for towards the northwest along the Missouri in Nebraska, the nearer they will be found to be to the surface until the overlaying cretaceous begins to thicken greatly. This latter is the case towards the Niobrara. Towards the southeast from Ponca along the Missouri, in Nebraska, Iowa and Missouri, these upper carboniferous beds thicken until they reach their maximum of 2,000 feet in Missouri. The practical difficulty in mining for coal from Omaha southeastward along the Missouri will not be so much the depth as an enormous pressure from water.

3. The Leavenworth beds, owing to their comparative thinness, and for other reasons mentioned, must be in the upper coal measures.

4. Whether any additional beds of coal exist beneath the one already found at Ponca can only be ascertained by actual boring. This test will probably be applied by the Ponca company. In the coal fields of Iowa,

from three to four coal beds exist below the first, varying in thickness from six inches to six feet. The lowest rarely exceeds a distance of 80 feet from the first, and generally they are much closer together than that. There is, therefore, a probability, amounting almost to a certainty, of finding additional beds of coal at Ponca beneath the one already reached.

Prof. Aughey also examined the borings from the test well preserved by the mining company during the process of the work. The materials passed through are reported as follows:

	Feet.
Loess	25
Blue clay and silica	50
Blue clay and brown sandstone	175
Sandstone of the Dakota group	175
UPPER CARBONIFEROUS.	
Sandstone and clayey matter	185
Coarser sandy material, brownish black	195
Dark clayey siliceous matter	215
Coarse dark carbonaceous sand	225
Shaley pudding stone conglomerate	235
Siliceous shale	255
Shale containing small pieces of coal	265
Loose sand rock	275
Fine shaley conglomerate	285
Siliceous calcerous shale	295
Fine silicate of lime	315
Shaley calcerous rock	325
Sand rock	335
Coarse sand rock	345
Limestone	355
Fine conglomerate	365
Dark colored limestone	450
Sandstone	458
Bluish shale	460
Magnesian limestone	465
Fine conglomerate and quartz crystals	475
Magnesia limestone	485
Minute quartz crystals, zinc blende and iron pyrites	500
Limestone	520
Siliceous limestone	540
Wash gravel	550

Darkish coarse sand	**557**
Brown sand rock	**570**
Coal, 4½ feet	**574½**
Hard siliceous fine grained sandstone	**584½**
Bluish black fine grained siliceous rock, 14 feet	**598**
Fine grained siliceous rock of minute cavities containing crystals, 2 feet	**600**

It is important that a number of tests be made at distances apart from each other of several miles, in the district or region where this new coal vein is reported. These borings, or tests, made under the most careful surveillance, will enable all parties to judge, unmistakably, of the extent and quality of the coal, before venturing a large sum of money in the construction of a coal shaft.

The Carboniferous Age.

***All the students of geology admit that the Carboniferous age was a very long one—an age whose length could not be measured by thousands, but by millions of years. During the greater part of this great age, Nebraska was occupied by an arm of the ocean. Sometines, for long periods, this sea was urbulent, as is indicated by the rocks, which so generally change their character within a few miles. A sand rock is often, when followed a few miles, changed to a shale, then to indurated variously colored clays, and then a conglomerate. Owing to this feature, the exact equivalent of the rocks at widely different stations is hard to distinguish, except along river bluffs, where the strata are exposed for long distances. The limestones having been formed in deep water, are more constant in character over extensive areas, but even these sometimes exhibit sudden transition characters. They present various forms and colors, such as silicates of lime and magnesia, nearly pure limestone, yellow, gray and white limestone, and shaly, rotten limestone. Many of the shales and conglomerates exhibit the character of off-shore deposits. If future boring brings to light beds of coal in the lower coal measures, it will be a proof of the existence, at that time, of dry land near by, and of a boggy, swampy condition on the sites where they are now found. As one foot of bituminous coal represents from nine to eleven feet of original peat, and many centuries are required for the formation of such an amount of vegetable matter, and as these beds represent only an infinitesimal amount of the time during which the events of this age were in progress, it is additional proof that its length was beyond all calculation. But during**

***From Prof. Aughey's Physical Geography and Geology of Nebraska**

its progress, deep seas and shallow seas, quiet seas and turbulent seas, and vast bogs and swamps near to slightly elevated land masses, in turn predominated.

The vegetation of the Carboniferous age was remarkable for its luxuriance and its antique form. In organization it was below the high modern types, but many of its forms were exquisitely beautiful, synthetic and complex.

The conifers that then existed, and which were the most advanced in type of all the vegetable forms, flourished mainly on the uplands. The most of them were closely related to Araucarian pines, which still flourish in low latitudes and mainly south of the equator. The fern family, of which a few diminutive representatives still linger among us, culminated in that age, many species growing to the dimensions of trees, and with a gracefulness and beauty unsurpassed by any vegetable forms of the present day. Many hundreds of species flourished over the forming coal fields of the west. In fact, one-half of the coal plants were probably ferns. The calamites of that day, which grew to tree size, are also abundant. The scouring rushes(*Equisetae*), which seldom reach over one or two feet in height, are their modern representatives. Two great orders, more abundant in the number of the individuals than any others, the Lepidodendrids and Sigillaria are no longer in existence. They, along with the calamites, formed a large part of the material of the coal. The Lepidodendrids had a dense bark, underneath which was a dense mass of loose tissue, through the center of which ran a small cylender with a distinct pith. Such a structure unfitted it for timber, but adapted it most admirably, when flattened down, for flakes of coal. The sigillarids, with "trunks fluted like Corinthian columns," and ornamented with seal-like impressions in vertical ranks, and "with few large branches and long needle-like, tapering leaves," were unfitted for anything except to make coal. It is remarkable that in the distant past, long ages before man appeared, the jungles and forests of the globe were as remarkable for beautiful forms as the woodlands of to-day.

Animal life during this age was abundant, though, as in the vegetable kingdom, the forms were mostly antiquated. One of the most abundant of all in individuals was the curious little animal, already referred to, which is frequently called fossil wheat or rice. It is, however, a lowly animal, classed with the protozoans, and known as *Fusilina cylindrica*. The shell is small, half cylindrical and bluntly pointed at the end, and averaging about the size of a grain of rice. Its shell is composed of seven or eight closely coiled whorls. Unlike its condition in Europe, it here ranges all through the coal measures. In John-

son county in many places around Tecumseh, it constitutes almost the entire fabric of many rocks, often from four to ten feet in thickness. It is often present in enormous numbers in shale, and where it has decomposed, hundreds can be picked up, already by the decomposition of the matrix lying loose and cleansed ready to be placed in a cabinet. All along the carboniferous exposures in Nebraska, it is abundant, in limestone, sand-stone and shale. The massive compact limestone from Stout's quarry, on the north side of the Platte, at South Bend, contains immense numbers of these Fusiliana, which gives the rock great beauty when polished.

Corals, which are now confined to low latitudes, were abundant in Nebraska during Carboniferous times. Five species have thus far been identified here. The most characteristic grew into a curious form remotely resembling a ram's horn. It is known by the name of *Campophyllum torquium*. A loose bed of shale in the bluffs at Rock Bluffs contains an immense number of them.

The Crinoids were represented by seven species at least, aud some of them existed in great numbers. While the heads of these sea lilies, as they are sometimes called, are occasionally found, owing no doubt to their fragile character, their screw-like stems and are abundant in all the rocks.

The question then returns whether there are or can be any good workable beds of coal in these upper measures. The old Nuckolls coal bed, worked near Rulo, in Pawnee county, in Otoe county, and at several places in Cass and Johnson counties, ranges from eight to eighteen inches in thickness, and in places is a fair article of coal. The bed at Aspinwall, which is from twenty-two to twenty-four inches thick, is not certainly its geographical equivalent. The same remark applies to a comparatively pure bed of light coal, from eighteen inches to two feet in thickess, on the Indian Reservation south of Rulo, near the State line. But no beds thicker than these have yet been found in these upper coal measures, and as we have seen, the probabilities are against their existence. If extensive basins of coal existed in them they would probably have been observed in Missouri, where they have been more thoroughly explored. With the lower coal measures the case stands different. These are the coal-bearing measures in Iowa and Missouri, and at least in one place (Lincoln), where they have been penetrated, a respectable coal bed was reported. All the chances then are in favor of finding large, workable beds at this horizon. This is a question that should be speedily settled at public expense. If there are workable beds, the State should have the benefit of it as soon as possible. An artesian boring within six miles

of the Platte river, near its mouth, to a depth of 1,000 feet; another near Nebraska City, and one near Rulo, would settle this question.

The Permian Age.

This age was the last volume in the history of Palæozoic life. The great Appalachian revolution was only partially completed, for the upward movement still continued. The peculiarities of the coal age had ceased, but its impress was left on Permian times. While the upward movement was advancing toward completion, at many places, especially in Europe and Asia, around the borders of the old coal fields, depressions still existed for extensive seas which received the sediments that entombed and preserved the organic remains of the age. Hence we have records of the earlier part of the age, but none of its latter portion, because the continents reached such an elevation that all the seas were drained, and no place was left to stow away the debris and worn-out life of the period. The process of uplifting, therefore, was continued until the continent was raised far above its present level, during which none of its memorials could be preserved. The whole latter portion, therefore, of the Permian, a portion of time incalculably long, is a lost interval in geological history. For the first time in geological history the conditions were favorable for the complete drainage of the continent. Lofty mountains produced great rivers and steep inclinations towards the sea. Clear skies took the place of murky ones in the previous age. The seasons gradually became more changeful and varied. The old vegetable and animal life was not adapted to these conditions and hence it had to change or perish. As a matter of fact during this last interval occurred those mighty changes in the fauna and flora of the globe which formed the Palæozoic life into the middle or Mesozoic world.

In the United States the Permian deposits occcur mainly in Kansas and Nebraska. Here the western boundary of the Permian passes a little west of south, a few miles east of Lincoln, extending to Beatrice, and thence into Kansas. Opposite Lincoln it is only a few miles broad, but widens going southwest and through Kansas. Towards the west at Lincoln and Beatrice it passes under the Dakota group of the Cretaceous. It is, however, as already intimated, only the lower Permian that is here represented. In the earlier Permian this portion of the continent was not raised above the old Carboniferous seas, and of course it received the sediments brought down by the rivers and creeks from lands sloping towards the west, on the east, north and northeast. These lands were partially the upraised Carboniferous sea bottoms. As elsewhere, the progress of elevation left the latter Permian here without any memorials of its existence.

It is possible that in some sections of the old world, not yet geologically explored, remnants of this as yet lost interval will be discovered. If so, we will no longer be compelled as now to people this age with the changing life that then must have existed. The old notion of cataclysmic changes of sufficient force to destroy all life, and subsequently entirely new creations has long since been abandoned. "Nature rarely turns a sharp corner." Life has not ceased on the globe since it began. In obedience to new conditions it has ever been changing into new forms. And in no period of world history have the transformations been so great as during the Permian Age.

Near and around Beatrice there are many exposures of yellowish, occasionally bluish magnesian limestone, full of geode cavities lined with calc spar. This rock is arranged in layers from four inches to two feet thick; and the whole series of strata are from twelve to twenty feet thick. Below this there is a bed of yellow compact limestone from eighteen inches to three feet thick. Next below there is a thickness of from eight to twelve feet of a dark grayish clayey limestone, also full of geode cavities, lined with crystals of calc spar, and sometimes of silica or silicate of lime. This stratum often becomes light colored on exposure to the air. Occasionally it becomes massive cream colored limestone. Wherever, therefore, such beds as thus described are found in Nebraska, bordering the Upper Carboniferous rocks, they invariably indicate our Permian deposits. Towards the east, in Pawnee county, they run out, as the Carboniferous then becomes the surface rock, which, on the contrary, in a westward direction, runs under the Permian. Above the first of these Permian rocks there is a bed of variegated clay, and sometimes of potter's clay, whose geological age is uncertain, but which probably belongs to the Dakota group of Cretaceous rocks, which comes in next above. This Dakota group, itself, can be recognized by its dark gray, brownish and red sandstones, which are round and westward from Beatrice overlies the Permian.

The Cretaceous Period.

As is well known, the name Cretaceous is taken from the Latin *Creta*, meaning chalk, which is exceedingly abundant in deposits of this age in Europe. This, the closing period of the Mesozoic or Reptilian Age, is well represented in the rocks of Nebraska. It is somewhat remarkable, however, that no equivalent of the European lower Cretaceous has yet been found in the West. In Europe the lower and middle Cretaceous were periods of subsidence, and therefore it is probable that this was the case here. This sinking extended over a large part of the Rocky moun-

tain region, and embraced the plains of Nebraska as far east at least as Fort Calhoun, on the Missouri, and north of that point to a considerable distance beyond it. From Fort Calhoun, the eastern line of subsidence extended in the opposite direction first southward and then southwestward, entering Kansas a little west of the Otoe Reservation. At least thus far east the lower member of our Cretaceous system is found.

THE DAKOTA GROUP.

This was so named by Hayden because of its great development southwest from Dakota City in Dakota county. Begining from below, it consists in the main of a whitish clay from a few inches to four feet in thickness, then various thicknesses of conglomerate and concretionary sandstone averaging from one to ten feet; next yellowish coarse sandstone, from fifteen feet and upwards; and next a red hard ferruginous sandstone containing impressions of plants, leaves, wood, etc., from thirty to seventy feet in thickness.

The Dakota Group towards the west extends under the Fort Benton and Niobrara Groups, and therefore its real breadth cannot be ascertained. I have traced it, however, from east to west over a breadth of from sixty to ninety miles. In the States of Iowa and Kansas Lesquereux estimates its breadth as slightly greater. Its eastern boundary is that of the cretaceous. It is mainly found in the following counties: Dakota, Wayne, Winnebago and Omaha reservation, Burt, Washington, Cuming, Stanton, Colfax, Dodge, Douglas, Sarpy, Saunders, Butler, Seward, Lancaster, Cass, Gage, Jefferson, Saline, and occasionally in the counties bordering on these. Southwesterly it has been traced to Texas. It crops out in numerous places as the basal member of the cretacious aeries in the mountains. It covers a large part of northwestern Iowa, and extends towards the northern limits of Minnesota. There are evidences of its presence in British America. Prof. Heer has also described fossil leaves from Greenland, some of whose genera and species are identical with those from the Dakota Group, and therefore it is probable that it has been continuous, as Lesquereux remarks, from the Gulf of Mexico to Greenland, and other Arctic lands, or over-thirty-five degrees of latitude.

We have already seen that during at least the lower Cretaceous, Nebraska, with a large part of the Rocky Mountain region, was an extended land surface in process of slow subsidence. By the time the middle Cretaceous began, this subsidence had reached so low a level as to admit the Gulf of Mexico, which spread over the area where the sediments of the Dakota Group are now found. There

can be no question about the Dakota Group being a shallow sea and beach deposit. Just such materials are now being deposited in existing shallow seas. Examples can be seen along the North Sea, on the South Sea, on the Belgian coast, and along the shores of Holland, where there are extensive muddy flats composed of substances which if compacted would be similar in constitution to the Dakota sandstone. Small grains of sand are rolled up by the sea which are mingled with the mud deposits brought down by the rivers. The rivers bring down iron held in solution, which is deposited in the presence of organic matter on the bottoms, often giving the grains of sand a coating, which subsequently became loosely compacted sand rock with a rusty, red, or brown color. "Marine animals, especially shells, are rare in deposits of this kind." "It is shunned by every kind of land animals, and it has therefore no other remains imbedded in its compound but saurians and rarely fishes. It has no remains of marine plants, because these do not grow on the soft ground."—LESQUEREUX.

It is from sixty to one hundred miles broad, and adjoining and overlapping the Carboniferous and Permian, it extends from Texas through Minnesota to, and probably through British America to Greenland. It is not conceivable that there should be a fresh water deposit of such extent. The homogeneous character of its materials also contradicts this view. No American geologist, however, ever entertained this opinion.

FOSSIL LEAVES OF THE DAKOTA GROUP.

As early as 1858 Dr. Hayden had obtained impressions of dicotyledonous leaves from the rocks, which he subsequently named the Dakota Group. They were remarkable for their modern aspect, as most of the genera to which they belonged are still represented in our existing flora. There have been found thus far in this group 132 species, distributed among seventy-two genera. Of these there were of non-flowering plants seven species, and six of these were ferns. Of naked seeded plants (*Gymnosperms*) there were seven species, one of which was a zamiæ, and six coniferæ. Two of these belonged to the giant cedar family, (*Sequoia*) and one a glyptostrobus, similar to the one still growing in China and Japan. There were three moncotyledons, one of which was a palm. The dicotyledonous trees, called also exogens (*outside growers*), to which division all our common trees belong, were the most fully represented, all the remaining forms belonging to these classes. Among these there were five species of populus, the genus to which our cottonwood belongs. Closely allied to the last were four species of populites. Of the willows (*Salix*) there were six species. The

oaks (*Quercus*) were represented by eight species, and the beeches (*Fagus*) by two. There were six species of buttonwood (*Platanus*) and one fig tree. There were two species of spicewood (*Laurus*) seven of sassafras and two of cinnamonum. The tulip trees (*Liriodendron*), which are among the most magnificent of all modern trees, were represented by three species. One buckthorn (*Rhamnus*) one walnut (*Juglans*) and one sumac (*Rhus*) have left their remains in this group. Even an apple (*Pyrus*) and a plum (*Prunus*) flourished in those times.

In such vast quantities are these leaf impressions that they convince anyone of considerable forests or groves growing in that pre-historic period. It is also most probable that these leaves were the foliage of trees growing upon the shores of a sea or upon islands, and that as the forests casts their leaves myriads fell upon the shores, daily overborne by the tides or into pools or larger bodies of water, in which a depositing sediment buried them. However this may be, we find them now, as we cleave open the massive rocks, just as perfect in shape, and every particular, except color, as when they rejoiced in the sunshine and showers of the distant cretaceous period.

No place in the world, as far as known, affords such an excellent opportunity to determine with positive accuracy, the absorbing questions of vegetable life, as related to the past and present. The leaves here preserved in stone are so perfect that the skilled botanist at once recognizes every species, and makes his classifications as readily as if he were dealing in the daily contributions gathered by a class in botany, from our common groves in the month of June.

Not only forms of leaves, complete and perfect, but the venation, or system of veining, is as distinct as in the living species. Even those finer branchings that are the plaited tissues, or the web and woof of leaves, are clearly and distinctly impressed.

Considering the period of years, or how long these Dakota catacombs have held these buried leaves, it will be most proper to allow a vast cycle of time, because many and mighty changes have taken place since that day, to accomplish which, in the ongoings of nature, imply an almost incredible chronology.

The modern geologists, such as Huxley, and the apostles of Darwin, would have us concede to them about five millions of years ago, when the great cretaceous flora had obtained its perfection on the shores of an ancient sea, that then marked the topography of Nebraska.

In comparing the descriptions of the celebrated Lesquereux with Gray's description of the living species, both botanists use the same expressions. For instance, Lesquereux's description of the sweet gum (*Liquidambar*) of the ancient flora, "leaves broad, 10 to 16 centimetres; 8 to 15 centimetres long; lobe entire, slightly enlarged in the middle; ozate lanceolate, obtusely pointed; nerve palmate, a little above base of leaf." Compare this with Gray's modern description, viz: "Leaves rounded, five to seven lobed, serrate, the lobes pointed, etc., etc.

Again, take Lesquereux's description of the ancient beech tree (*Fagus*,) "Leaf, ovate, oblong, cuneate to the base; borders entire and undulate; medial nerve, straight; secondary veins close, numerous, simple, parallel," and compare with Gray's modern species: "Leaf, oblong, ovate, taper pointed, often coarsely toothed, etc.

It is not difficult in this careful manner to identify the ancient species of this petrified flora, and point out its exact resemblance to the living species of our present groves and forests.

But what is more wonderful, Lesquereux declares this ancient Nebraska forest, in all its beauty and perfection, as appearing suddenly, and not as related to any ancestry. It springs up full and perfect, showing no lineage or line of development from any primordial types and forms.

He says: "It is possible, of course, to suppose an intermediate and unknown land formation where, in an immense space of time the plants of a lower grade have developed those primitive types and multiplied them in the cretaceous epoch. But the cretaceous flora does not preserve any race of these ancient forms. Among its 132 species all except nine represent flowering, or phænogamous plants, distributable not in a single one, but in all

the essential groups of vegetables living at our time. All these types are present in the North American flora, some of them without any alterations of forms.

As long as we remain in the domain of suppositions it is easy to go along in that way, and to ascend from one or more primitive forms for the building of a progressive scale of vegetables, by new deviation or multiplication of organs. But until we know more we have to consider the facts, and the conclusion evidently forced in upon us, considering the flora of the Dakota Group, is that its disconnection from ancient types is so wide that even the supposition of intermediate unknown extinct vegetable types fails to account for the origination of its peculiar character.

This large group of perfect vegetable species in the Dakota sandstone, coincident in detail with living species, is quite annoying to the evolutionists and followers of Darwin. Prof. Marsh, and others of this school, claim that species are constantly changing. "All life, living and extinct," says Marsh, "has been evolved from simple forms. The rapidly converging lines of research as pursued to-day, seem to meet at the point where organic and inorganic nature become one; that this point will yet be reached I cannot doubt."

The class of authors here quoted, all agree in referring the varied profuse and complex vegetation of the present era to a few simple forms in the indefinite past, and these simple forms to one form or type at the outset. This theory, of course, implies that poplars were formerly not poplars, but existed potentially as willows, or laurels; that oaks and maples were evolved from cycads, or some other ancestral forms, totally different from their present status; and so on, diminishing the 100,000 species, which are now living, to an ultimate shrub, or vegetable, which contained the potency of all forests, of mountain and plain.

Not wishing to disturb the excessive revelry of the imagination that is needed to hold all this in review, I will make only one inference, viz.: that on this plan, every known tree must have

constantly changed, and must be only in transit to some other form or species of trees, or in other words, the process and forces of nature have no constancy of equilibrium or action, but continually urge to the production of infinite variety, and this view independent of the bearing of any facts, is the platform of the evolutionists.

In the midst of this multitudinous scamper of "scientists," as they are pleased to call each other, in their eager rush to find the germ of man, animal and plant; in the amorphous monera or microscopic zoophytes, self-evolved out of self-crystalized particles of self-existent matter, it is most refreshing to call a halt here among the quarries of the Dakota sandstone, and in the shade of a grove of living oaks, poplars, and willows, ask concerning their origin and relation to the buried forests of identical species beneath our feet.

If now, in a period of five million years, the leaf of the willow or oak shall not change by any appreciable difference in form, how many million of years must elapse to produce difference enough to make a variety? and how many more millions of years to make, by the law of natural selection and survival of the fittest, an actually new species?

Thus, when we remove the problem of development and evolution from the realm of imagination to the region of the Dakota group, and apply to it the actual test of the microscope, or even the unaided vision, we find an array of evidence against these theories that have never been answered, and in the nature of the case never can be. Nothing is claimed here that cannot be seen by any botanist who has had a single year to study and compare leaf forms; not only this, but the ablest living botanist was obliged to give to the ancient leaves here found their proper name and place, at once, among the present order of species.

According to Darwin, if the rocks of the Cretaceous era, shall present perfect forms of present species, still earlier formations should afford some vestiges of the same species, which Prof. Lesquereux clearly declares is not the case. Again, according

to the theory of Darwin and Huxley, the effect of modifying conditions is such that the succession of life will constantly deviate from parent types, and in after ages present forms, not only changed and altered, but wholly unlike. The investigations here made are directly subversive of this dogma of the evolutionists.

Considered as evidence in the theory of evolution, the remarks of Prof. Huxley should be taken in precisely the same manner as the testimony of a deeply interested witness in a superior court, where a grave case is being tried. It appears from the evidence that Prof. Huxley, who, forty years ago, belonged to the Voltaire school, has written all his deductions in science with a foregone conclusion, to start with, and we need not be surprised at his sweeping propositions, in which he extinguishes those who do not interpret science according to his favorite dogma.

Not only is the theory of evolution "not proven," and not accepted by the most philosophic and rational class of scientists, among whom we name Dana and Dawson, in America, but its hold is waning rather than increasing, on the public mind.

The Fort Benton Group.

The preceding period was closed by the changed conditions brought on by a further subsidence of the region where its deposits are found. Where shallow seas and extended beaches and flats full of small islands had obtained, now rolled deeper waters and quieter seas. The deposits formed during these times have been called by Hayden the Fort Benton Group. They are dark gray laminated clays, sometimes alternating near the upper part with seams and layers of soft gray and light colored limestone, filled in many places with marine shells. Occasionally in Nebraska this group may contain seams of impure lignite and other carbonaceous matter. It lies conformably on the Dakota Group below. It is so friable and easily eroded and disintegrated, that wherever it is left exposed, so far as I have observed, it has disappeared. In many places, however, where deep sections have been made by canyons and railroad cuts through the Niobrara Group, which lies above, its deposits are almost invariably present, and often in notable thickness. One of the finest of these exposures is seen below the mouth of Iowa Creek, in Dixon county, along the Missouri bluffs. Here for a long distance

the line of demarkation between the Dakota, Fort Benton and Niobrara group are distinctly seen and clearly outlined. Below Milford, on the banks of the Blue, and at other points in Seward county, in deep sections, it is also observed.

That this period was a long one is evident from the fact that its deposits are in some places 800 feet thick. The materials, too, are of a kind that are slowly deposited. It is probable that the numerous low islands that had existed in Nebraska during the previous epoch, had now mostly disappeared beneath the constantly deepening seas. Some land surfaces existed in Southeastern Nebraska, but no such memorials of its condition have come down to us as marked the previous epoch.

The Niobrara Group Epoch.

A still further subsidence of the continent, especially toward the north and west, inaugurated the Niobrara Group Epoch. Hayden gave it this name because of the great development of its deposits below the mouth of the Niobrara in Northeastern Nebraska. Here the deposits consist of an impure chalk rock, varying from a grayish white to a pink bluish and yellow hue. Below the mouth of the Niobrara many of the chalk bluffs are several hundred feet high, with a perpendicular face often excavated beneath by atmospheric agencies. These chalk rocks are seen through Knox, Cedar, and in many places on the Lower Republican. Elsewhere the deposits, those beneath the stratum of chalk, are mostly of an impure limestone, which often shades imperceptibly into a silicate of lime. This stratum is often called the Inoceramus bed, from the immense numbers of this mollusk which frequently compose it. Under the Inoceramus bed there is in many places toward the southwest, a stratum varying from a few inches to fifteen feet in thickness, of an impure, yellowish, silicious limestone. According to Prof. Mudge, it is the characteristic feature of this group in Kansas. It can be observed at Milford in Seward county, in places in Harlan county, and at many other points between these stations. Lately a chalk bed of this deposit was found near Red Cloud, in the Republican Valley. It is a pure white, soft, easily worked, and contains little besides carbonate of lime and a small amount of iron carbonate, but not sufficient to color it. Judging from microscopic and chemical tests, it is as pure as the best European chalk.

The Niobrara is the most widely extended of all the Cretaceous groups in Nebraska. In Southern Nebraska, from the western line of the Dakota Group to Harlan county—where it is overlaid by the Pliocene, it is over 100 miles wide. In North Nebraska, from Dakota county—where it begins

to overlie the Dakota group, it extends westward for over 150 miles. In general, the area on the geological map marked Cretaceous is all Niobrara Group, except a border from sixty to one hundred miles wide on the eastern rim, from the Omaha Reservation southward, which mainly belongs to the Dakota Group. As before intimated, it was mostly a period when deep seas overspread a large part of the area now covered by its deposits. Southeastern Nebraska was also a land surface during this Epoch. The eastern border, at least, of the Cretaceous area, was the eastern shore line of the interior sea of the time.

The peculiar impressions of geological modern leaves (*dicotyledonous*) which characterize the Dakota Group are wanting in the Niobrara. Different seas now prevailed, evident from the fossil animal remains obtained from this group in Nebraska.

Fossil wood, however, is abundant, both petrified and agatized. Of this material I have made micoscropic sections of seventy-nine specimens, which under the microscope showed the structure of the original wood. Of these, forty-seven belong to the conifers of the araucarian type, and the balance were cycads and zamias. Judging only from these few remains, the dicotyledonous vegetation that characterized this region in Dakota Group times, had retreated, probably northward or northeastward. A southern flora, or one that had reached its culmination in Jurassic times, returned again to this region by migration. At the same time a few species from the Dakota Group era lingered among these mediæval vegetable forms.

The chalk of Europe was largely made up of remains of rhizopods, which were so abundant that a cubic inch, according to Ehrenberg, contained millions of these low organisms. In our own chalk seas they were probably little less abundant, though less well preserved. Some specimens of chalk that I obtained below the mouth of the Niobrara, and in Cedar county, afforded them, under the compound microscope, in immense numbers. Often, however, no trace of these organisms is left. I found them where they had apparently been preserved from crushing, first beneath the huge scale of a fish, and then in the hollows of reptilian vertebra. As in the European chalk, the spicula of sponges are occasionally found in this group.

This era was evidently well adapted to the support of molluscan life, though the number of the species is less than from the preceding and the next two following. The number of individuals, however, is enormous.

The seas of this era swarmed with fishes. In the chalk in Knox and Cedar counties, for over a hundred feet through it vertically, almost every spadeful of rock contains fish scales or teeth or both. Many of

the species were of reptilian type, or at least were predaceous and allied to the modern salmon. Cope has described forty-eight species, most of which were from the Niobrara Group in Kansas. Many of these I have identified from the same group in Nebraska. One of the most abundant of these fishes, and also one of the most rapacious that ever existed, is known as *Portheus molossus.*—Cope. Its bones are sometimes found to project from the sides of the limestone bluffs in the Republican Valley.

"The head was a few inches longer than that of a grizzly bear, and the jaws even deeper in proportion to the length. The muzzle was shorter and deeper than that of a bull-dog. The teeth were long cylindrical fangs, glistening, and of irregular size. At certain points in each jaw they projected three inches above the gum, and were sunk one inch into deep pits, being thus as long as the fangs of a tiger, but much more slender. Two pairs of such fangs crossed each other on each side of the end of the snout." Six species of these rapacious fishes have left their remains in these rocks, and probably more will be found with the progress of discovery.

In this group in Nebraska, the remains of sharks are quite abundant. Many fine specimens of their teeth have been obtained in the Inoceramus bed at Pleasant Hill in Saline county, from near Seward, Milford, and in Dakota county. Some of these represent the pavement teeth (*Cestraciont —Pycodus Mortoni*), and others the common modern shark family.

Many reptilian forms from the west have been described by Leidy, Marsh, and Cope. The latter, from the Niobrara group of Kansas, alone, has described thirty-seven species of reptiles. Many of these I have identified from the same group in Nebraska, and as this group is continuous through these two States, it is almost absolutely certain that they all, or their equivalents swarmed here during those times. What adds to this probability is the certainty that there were deeper seas towards the northern boundary of the Niobrara group waters. "In the deep seas of this era could have been seen an animal lying on the water, with a body of elephantine size. Its neck was twenty-two feet long, snake-like, and with an arrow-shaped head. One minute it would run this long neck in the water, and then, raising it up, would peer for victims over the deep. Its tail was also of serpent pattern, and served to balance it behind, or propel it through the water, though it also had two pairs of paddle-like limbs, resembling those of the Plesiosaurus, from which it differed mainly in the arrangement of the bones of the breast. This is the *Elasmosaurus platyurus*, (Cope), a carniverous sea reptile adapted to deep water. Its total length was fifty feet. It was structured to swim below

or on the surface, and while lying still would explore the depth forty feet below without changing the posture of its body. That it fed on fishes, is evident from the scales and teeth found in the position of its stomach."

A species similar to the last, and also described by Cope, was the *polycotylus latipinnis*. It was extraordinary for the length of its neck and attenuated head, though its tail was short and massive, doubtless to balance its long neck while moving through the water and capturing its prey. It was a powerful swimmer, as is evident from its two pairs of paddles, four feet long, with a lateral expanse of from eleven to twelve feet. The bones of a reptile found near Sheridan, Kansas, has been referred to the genus Plesiosaurus, of which there have been found and described the remains of many species in the European chalk. The two preceding and this last (*Plesiosaurus gulo*) are the only ones in this large family of *Sauropiergia* that have yet been found in the Cretaceous in the West. This is evidently, as Cope has remarked, because of the presence of another order, almost entirely absent in Europe, but the real rulers of our Cretaceous seas—the Pythonomorphs or Mososaurs of Leidy. These reptiles had characters that related them to the lizards and serpents, and in the absence of a sternum, to tortoises and Plesiosaurs. They pre-eminently characterized the Cretaceous seas of America, being found in the deposits of this age in Alabama, New Jersey, and especially in Kansas and Nebraska. One-half of all the reptiles found here belong to this order, but only four species have yet been found in Europe.

The most gigantic of these reptiles (*Liodon proriger*, Cope), attained a length of not less than seventy-five feet, and probably much greater This species was very abundant. It had a long projecting muzzle, remotely resembling that of the Atlantic bluntnosed sturgeon, but the ends of the lower jaw were much more blunt and massive. Such an arrangement must have made it a terrible ram, and no doubt it often stunned its victims by a butt before swallowing them. *Liodon dyspelar*, Cope, was perhaps equally as large as the preceding, but by no means so abundant. Two somewhat smaller species of *Liodon* occupied the same seas.

A genus closely related to the last, and whose remains are specially abundant in Nebraska, is *Clidastes*. The species of this genus were more flexible, and much more elegant in form than the Liodons, also less in size. "Perhaps to prevent their distortions from dislocating the vertebral column, they had an additional pair of articulations at each end." (Cope). One of these species (*Clidastes tortor*, Cope), was only thirty feet long, but its narrow pointed head had a length of thirty inches. Its teeth had cutting edges lengthwise of the animal, and in the lower jaw were eighteen in number. "The palate was armed with eleven teeth."

The light and slender bones and elongated vertebrae indicated that this reptile was of unexceptionably slender proportions. The largest species (*Clidastes cineriarum*), was about forty feet in length.

Tortoises have long been known from the Cretaceous of the Atlantic coast, but have only lately been described from the Niobrara group. Three genera and as many species are now known. The largest (*Protostega gigas*, Cope), had a spread of expanded flippers of over fifteen feet. The ribs in this species did not entirely coalesce, and in its entire structure it was like an ordinary turtle just hatched.

Only one species of Dinosaurs has been found in the Niobrara group. They were no doubt abundant in this era, but the conditions for their preservation were not favorable. Many have been found in the geological equivalent of the Niobrara in New Jersey. They were present in considerable numbers during subsequent Cretaceous eras, and no doubt on the land surfaces of the time they were rulers.

Nothing is more remarkable about this marvelous age than the peculiarities of its bird life. Like all other vertebrate forms, it was almost entirely of the reptilian type. Thus far eleven species have been described from the Niobrara group deposits. The New Jersey green sand has yielded five more. The Saururæ were the most remarkable, as they combined fish, reptile and bird characters. They are embraced in two genera, *Ichthyornis* and *Apatornis*. They had no horny beak, like modern birds, but in lieu of it they had slender, thin and long jaws, filled with sharp conical teeth in sockets, numbering at least twenty on each side below, and Marsh thinks as many above, though that could not be ascertained from the specimens. Of the former there were two species, namely, *Ichthyornis dispar* and *I. celer*. The generic name (*Ichthyornis*), means fishbird, referring to the fish-like structure of its vertebræ. They had a keel on the breast, like modern birds, for the attachment of the muscles of flight. Marsh supposes that the tail, which was not found, was vertebrated like the old Jurassic birds, but probably shorter and less reptilian. In size they were not larger than pigeons, but were capable of flight.

From these brief outlines, it is evident that there was a most vigorous life during the Niobrara group times. The oceans swarmed with many kinds of fishes, a large proportion of which were rapacious. Gigantic reptiles flourished on sea and land. Flying saurians navigated the air, many of them of huge size. Reptilian birds abounded, of all sizes, from diminutive forms to gigantic dimensions. During the earlier and middle portion of this era, the Niobrara ocean was connected on the west with the Pacific. Later, the sea bottoms were raised up along the Rocky mountain chain, giving access and egress alone from the Gulf on the

south, and the Arctic ocean on the northwest. A slow process of elevation continued on the east as well as on the west, contracting this ocean to even narrower limits. A reverse movement was now going on from what was taking place early in its history. Then it was in process of subsidence, now it is in process of slow elevation. When sand bars eventually were thrown across the channels of moving waters, much of its life was imprisoned and gradually destroyed. The most vigorous species and individuals would last the longest, but all eventually had to submit to the inexorable fate of final extinction.

Fort Pierre Group.

The preceding (Niobrara Group) era came to a close by a continuation of that process of elevation that eventually drained the region where its deposits now constitute the surface rocks. Two regions of Nebraska contain these deposits. One of them is in Northeastern Nebraska, in Knox county, below the mouth of and for a short distance along the Niobrara. The other is on the Upper Republican, towards the west line of the State.

The materials of the Fort Pierre group, in Nebraska, are made up largely on the Upper Republican, of occasionally thin beds of brownish sandstone, underlaid by dark gray plastic clay, calcareous shales, sometimes containing sulphuret of iron, and more rarely carbonaceous matter. A large amount of gypsum is present, which often has the form of sclenite. The star-like shapes which it frequently assumes, makes it desirable for cabinets. The masses of sclenite scattered over these deposits, on the Missouri bluffs, beyond the Niobrara, has given them the name of Shining Hills. From the occasional presence of scales of fishes, and still more rarely of ammonites, and other chambered shells, I conclude that only the lower member of this group is present in Nebraska.

On the Upper Republican this group in many places lies beneath the Tertiary, and can only be seen in cuts and canyons, and the sides of bluffs and ravines. It almost certainly extends from near the mouth of the Niobrara in a southwesterly direction across the State. Passing beneath the Tertiary, it is not seen again until the Western Republican region is reached in Hitchcock and Dundy counties. It runs, therefore, proximately parallel to the Niobrara group, and on its northwestern side.

The Fort Pierre sea, that extended diagonally across the State from the mouth of the Niobrara and beyond, represents a depression left or made after the elevation of the Niobrara Group area above the old oceans. The rarity of organic remains in this territory in this group is indicative of that unfitness for life which characterizes a sea that is losing more

water by evaporation than it gains. Gypsum, which is so abundant in this deposit, is also formed under the same circumstances. Hence the vegetable and animal life that it here at first possessed gradually but surely was exterminated.

The thickness of this group on the Upper Missouri is not less than 700 feet. There are a few localities where it is even greater. It was therefore a very long era; so long, indeed, that the ages of human history are as nothing compared with it. During all this time a large portion, and after the middle of the era the greater portion of what is now Nebraska, was again an extended land surface.

From the few vegetable remains in the form of petrified and agatized wood that have been preserved, it is evident that the vegetable kingdom was represented mainly by the forms that characterized the preceding era. These, it will be remembered, were mainly cycads, zamias, araucarian conifers and tree ferns.

The animal life of the seas was probably richer than in the preceding era in molluscan forms and poorer in reptilian life. The Cretaceous, the last period of Mesozoic times, was drawing to a close, and with it its characteristic life.

THE FOX HILLS GROUP.

No deposits of this group are exposed in Nebraska, and it is uncertain whether any exist in the State. If they are present they underlie the Tertiary in the northwestern part of the State, As this group constitutes the surface or upper rock in the Fox Hills, it is possible that it also runs in a southwesterly direction, and underlies the Tertiary in Northwestern Nebraska, as stated above. In doing so it would follow the law of the preceding groups in Nebraska, each of the newer following after the preceding on its northwestern side. Its thickness is about five hundred feet. It is largely composed of gray ferruginous and yellowish sandstone and arenaceous clays. During the deposition of these deposits the greater part of Nebraska was an extended land surface. Nebraska doubtless drained into this Fox Hills sea, but the sediments that filled it up were derived mainly from land surfaces on the west and north, as is indicated by their character. That it was also a long period is evident from the thickness of the deposits—500 feet in the region of the Upper Missouri. Its maximum thickness is 4,000 feet. At the most rapid rate of deposition the time involved in laying down such a mass of sediment is beyond calculation. According to Hayden, Meek and Lesquereux and others, it was the closing portion of Cretaceous and Mesozoic times in the West.

The vegetable remains found in the Fox Hills group still indicate the

presence of cycads, zamias, tree ferns and araucarian pines, but in greatly diminishing proportionate numbers. There is already a large admixture of more modern tree forms.

Animal life was specially rich in molluscan forms, closely related to that of the preceding group, or Fort Pierre fauna. Like the latter, it contains the remains of many chambered shells, such as baculites and scaphites, the latter being specially abundant and beautiful. Vertebrates were represented by numerous fishes and some large reptiles, the commonest being in the Fort Pierre group, (*Mososaurus Missouriensis.*) No doubt the plains of Nebraska, during this epoch, was the home of huge Dinosaurs, and reptilian birds, but their remains, under the geological circumstances of the times, could not be preserved to us.

LARAMIE GROUP.

This is the Lignitic group of Hayden. Like the preceding, it is not exposed in Nebarska, but may be present in the northwestern part of the State, underlying the Tertiary. As this group is known in numerous places to pass under the Miocene, its presence in northwestern Nebraska in the same position is not impossible

It is the last of that series of groups, commencing with the Dakota, that are conformable through their united thickness of not less than 12,000 feet in the Rocky Mountain region. Of these 12,000 feet of sediment, four-fifths are of sandy materials, more or less mixed with calcareous deposits, which were derived mainly from a land mass that was raised up at the close of the Carboniferous, and extended from the Wasatch west of the meridian of 117° 30min. for 200 miles westward, and for an unknown distance north and south. The materials of this land mass were mainly silicious, and fully seven-tenths of the deposits that constitute these cretaceous rocks came from their disintegration and erosion. At the close of each epoch represented by these groups, the shore line of the old interior cretaceous ocean retreated further to the west and northwest. By the time the Laramie epoch was reached it was, during much of the time, only a vast marsh or bog, full, no doubt, of low islands, and subjected often to incursions from the sea, and again constituting an estuary, and occasionally even becoming a fresh water lake. All this is evident from its vegetable and animal remains, which sometimes are marine, sometimes land, and sometimes of brackish and fresh water types.

The materials of this Laramie group are, like the preceding, principally sandstones, but varying a great deal more in lithographic character in different sections. Intercalated with the sandstones, at various

horizons, are clayey and shaly layers, and a few beds of pure clay, and many strata of carbonaceous shales. The principal colors are buff, pink, red and various shades of yellow.

Hayden considers that the area of the Lignitic (Laramie) on the Upper Missouri cannot be less than 100,000 square miles, without taking into account the great belt that extends far north from the United States into British America. Altogether, from British America to the Black Hills, the area covered is not less than 125,000 square miles. Between the Black Hills and the Rocky mountains, there is still another area of 1,700 square miles. The extent of the southern basin, which commences south of Cheyenne and extends to the Colorado plains, east of Denver, and southward to New Nexico, has not yet been estimated.

The most characteristic feature of this group, as already indicated, is the great nnmber of carbonaceous shales and true coal beds which it contains. Fifteen and twenty coal beds sometimes occur in the course of a thousand feet. Artesian borings at Rock Springs station in 700 feet brought to light seventeen coal seams, the principal bed being eleven feet thick. Some beds are known and worked that are over thirty feet in thickness. When the great extent of this coal field is considered, it becomes apparent that it is only second in importance to the coal fields of the Carboniferous Age. As is well known, the coal belongs to a series of lignites and is a superior article.

As the strata are almost horizontal, and few cañons cut through them, their study in Nebraska, in the absence of borings is difficult. It is possible, though hardly probable, that at some points in our extended Territory there may be basins of coal of good quality in these deposits. Even in the mountains, the thick beds occupy depressions in the strata and soon thin out, only to increase again in thickness farther on. To settle this question in Nebraska definitely, will require many borings, over a vast area of our territory. One of the most favorable regions for testing for these lignite coals is in Northern and Northwestern Nebraska.

With the close of the Laramie epoch, the whole series of conformable strata which had commenced with the Dakota Groups ceased. When the last sediments of the Laramie Group had been laid down, there occurred one of the great geological revolutions in the history of the globe. From the eastern base of the mountains to the Wasatch, the whole region was thrown into a series of folds and undulations. The Uinta Range, with its broad, flat anticlinal, was made at this time. The whole chain of the Rocky mountains, was lifted up, so as to leave a broad depression eastward of the Wasatch, and on both sides of the Uintas.—(King). The Laramie Group was turned up at all angles, from a few degrees to a ver-

tical position, as it is now found in many places beneath the superincumbent Tertiary. This upturning affected also the Cascade Range, which was then first outlined. The whole region of the plains sympathized with this movement, so that they became an extended land surface. Nebraska now certainly for the first time since the early Cretaceous, over its whole territory became a land surface. The elevation in the mountains became sufficient to give free drainage to the sea, and exclude the oceanic waters. The great interior sea became so completely exterminated, and the continent so elevated, that it has never since been subjected to the sway of the ocean. Henceforward, fresh water lakes become dominant down to the borders of our own times.

Next in order in the ascending series of the Nebraska system is the Tertiary Group, which in all countries retains the same name, with its subdivisions Eocene, Miocene and Pliocene, given by Charles Lyell, the celebrated English geologist. Only two of these divisions are as yet known in Nebraska, viz., the Miocene and Pliocene. As the limits of this volume permit only a condensed view of the geological system of Nebraska, the reader is referred to the larger and more exhaustive work of Prof. Samuel Aughey, which contains a minute description of the Tertiary rocks. The following extracts, as were the foregoing, are taken with the permission of the author, and intended only to briefly present the systematic Geology of Nebraska in a connected order.

Its exact geographical extent has not been ascertained in Nebraska, owing to the superincumbent Pliocene, which overlaps it, and through which it only projects at intervals. The best exposures in Nebraska commence on the Niobrara river, about 300 miles west of the mouth of the Keya Paha, or Turtle Hill River, and extend to the west line of the State, taking in the White Earth River region and the space between the latter and the north line of the State. It is finely represented on the north of the latter river in Dakota Territory, constituting there a portion of famous Ma- koo-si-tcha or Mauvais Terre of the French, which has been rendered into English by the term Bad Lands, although in the Dakota tongue it means simply a country hard to travel over. On the west the Miocene abuts against the undulating surface of the Laramie Group, and therefore does not extend quite to the foot-hills of the Colorado Range. The extent of this great fresh water lake has been variously estimated at 100,000 to 130,000 square miles.

The materials of these Miocene beds vary a great deal in character. This would naturally be expected in a lake bed which received the drainage, through countless ages, of the rivers that have their outlet through the Missouri.

The eroded materials going seaward were stopped in these old lake beds. Erosion, however, through the Miocene, was by no means as rapid as at present. The height of the plateau region was much less than at present; the atmosphere was moister, the rainfall much gentler and more constant, and a warm, temperate climate obtained. The extreme cold of winter, which is such a mighty agent in the disintegration of rock, and which now characterizes these regions, did not then exist. Hill, valley, plain, mountain and plateau, were also covered by dense growths, in places of grasses, and in places of mighty forests, which protected the land from the denuding agencies which are now constantly at work.

If we calculate the length of the Miocene times on the same principle as the Eocene, this epoch was probably a quarter of a million years. It should be remembered, however, that there is no certainty about the length of geological periods.

In Nebraska, on the north of the White Earth, and on the Upper Niobrara, the rocks of the Miocene have the following character: Indurated grit, of a reddish brown color, with occasional layers of concretions of silicate of lime, often shading into, first, a coarse and then a fine green sandstone. Above this occur, sometimes, immense masses of conglomerate, with occasional layers of tabular limestone. Then come coarse-grained sand-stone, often loose and friable, and sometimes compact and heavy bedded. A limestone layer, followed several miles, often changes into a silicate of lime, then sandstone, and then conglomerate, and the opposite.

A portion of this old Miocene lake bed, on the north of the White Earth River, as already stated, constitutes the Bad Lands. This is one of the most wonderful regions on the globe. Here, at present, there is very little, and in some places formerly there was no vegetation. This region is worn into labyrinthine canyons that wind around in every conceivable direction. Occasionally only isolated, sometimes almost perpendicular portions of the original beds remain, producing the appearance of abandoned human habitations or old desolated forsaken oriental cities. Climbing some of the heights, far as the eye can reach, there seems to be an interminable array of towers, spires, cathedrals, obelisks, pyramids and monuments. "Not unfrequently the rising or setting sun will light up these grand old ruins with a wild, strange beauty, reminding one of a city

illuminated in the night, when seen from some high point." The harder layers project from the sides of the canyons, or mimicked architectural forms, with such regularity that they appear like seats, one above the other, of some vast weird amphitheater. It is here among these strange, grotesque ruins, that the remains of the unique animals described farther on are found."—(Hayden).

As can be inferred from the preceding, during the Miocene epoch the greater part of the eastern portion of Nebraska was a land surface.

In Nebraska there flourished in Miocene times trees of the same gigantic character and even of the same genus, and probably of the same species, as now grow in the sequestered vales of California. Some of the United States geologists have, indeed, expressed the conviction that in that age Nebraska was covered by a vast savanna. I take the opposite ground because of the occurrence in the Nebraska Miocene beds of many species of trees. Besides these giant cedars that here bloomed heavenward, there were species of palms and fig trees, as stated above, and these helped to give the vegetation that warm, temperate, or semi-tropical aspect, which marked its facies as a whole.

Along with this warm temperate flora, there existed in Miocene times a still more wonderful animal life. Perhaps never have the conditions for mammalian life been so favorable as during this epoch. The few that can be noticed in this chapter simply illustrate its general character and richness.

The horse family (*Solidungula*) which is now represented by one genus (*Equus*), whose characteristic species are the horse and the ass, was rich in genera and species during the Miocene. We have already seen that the family came into being in the early Eocene, the first known characteristic form being the Eohippus. In the early Miocene we already have the Mesohippus, represented by several species whose distinctive peculiarity was that the fourth toe was rudimentary splint. Next in the Miocene came the Anchitheriums, which are represented in Nebraska by one species, with three additional forms in Colorado. The peculiar features of these horses was that they had three toes, all of which touched the ground, the two lateral, however, being comparatively small and weak.

These Miocene horses ranged in size from an animal much smaller than the ass to animals about the size of a small modern horse. Four genera of horses existed in Miocene times, each genus, however, being represented by from one to several species. They must have been exceedingly numerous, and doubtless roamed over our plains in countless numbers.

The elephants and the mastodons were already represented by several species. The remains of the one that I found on the White Earth, in Nebraska, were too much decayed to identify specifically. It bore the closest resemblance to the Mastodon Marificus that appeared during the next or Pliocene epoch.

Among the most unexpected of all the discoveries in the Nebraska Miocene was the remains of the Rhinoceros. One, the rhinoceros occidentalis,was about three-fourths the size of the Indian rhinoceros.

Genera closely related to the hog family (*Suidæ*) were abundant during this epoch. One of these genera (*Elotherium*), which was first described from the Miocene of France, was represented by several species during these times in Nebraska and Dakota. Five other genera of the Suidæ occur in these deposits. During this period it is evident that suilline animals existed in great numbers all over the land.

The most curious fact, perhaps, connected with the animal life of this epoch, was the presence of many species of the camel family. At present it is confined to Asia, Africa and South America. In the latter by the Auchenia or Llama. In Miocene times, however, they were reprsented in Nebraska by several genera and many species.

No family of animals was represented in that epoch by more genera, species and individuals than the Oreontidæ. Leidy, who first described them, called them ruminating hogs. The skull approached more nearly to that of the peccaries, though the upper part had some characters uniting them with the camels. The molars were like those of ruminants, and resembled most nearly those of the deer, but unlike modern ruminants, they had incisors in both jaws. The canines resembled most nearly those of a hog. The teeth, as a whole, formed an almost unbroken arch, a condition found in few animals besides the quadrumana. Like the hogs, too, they had four toes on each foot, two being functional, and the two on the sides being too elevated to touch the ground. They were, therefore, what Leidy called them, ruminating hogs. They were, judging from the abundance of their remains, more numerous than any animal of those times. They were gregarious, and must have roamed over Eastern Nebraska in countless millions. In size they ranged from an animal not larger than a raccoon to one as large as a small elk.

Among the carnivora of the Nebraska Miocene the cat family (*Felidæ*) were well represented. Among the most remarkable of the family was a genus of sabre-toothed lions (*Drepandon*). Its remains were first found in Western Europe, afterwards in Greece and Asia, and finally in both Americas. The largest species equaled the lion and tiger in size, and judging from their terrible array of destructive teeth were of even greater

ferocity. In comparison with the existing cat family they were characterized by a greater proportionate size and flattened form of the upper canine teeth, which has given these animals the name they bear. Drepandanon occidentalis was about the size of the existing panther.

Many additional species of mamals have been unearthed in the Miocene of Colorado, which have not yet been found on the plains, but which, no doubt, flourished here at that time. The preceding animal forms, however, are only a small part of the species that have been found, and all of those found probably are only a small part of those that flourished during Miocene times. During the whole of this epoch, which, as has already been stated, evidently was of long duration, there was a most happy combination of physical geography and climate. Warm, temperate conditions existed almost to the poles. In Nebraska the magnificent savannas and forests that covered the land gave shelter and food to countless numbers of the mamalia that here enjoyed a happy existence.

Like the preceding epochs, the Miocene was destined to come to a close. The changing conditions evidently were not sudden—they were of such a gradual character as slowly to alter the environment of the animal life of the times. With change of climate came change of flora, which in turn changed or destroyed the rich and wonderful Miocene forms of animal life.

THE PLIOCENE TERTIARY.

The Pliocene, in Eastern Nebraska, overlies the Cretaceous. In southwest Nebraska it lies on the Fort Pierre Cretaceous. Further west the disturbance, as already stated, was much greater at the close of the Miocene. On the plains the Pliocene beds, wherever their point of junction could be observed, are conformable to the underlying Miocene. Often they shade so insensibly into each other that the line of junction could only be ascertained by the fossils which they entombed.

Along the foot-hills of the Colorado range the Pliocene beds average nearly 2,000 feet in thickness. They thin out eastward, probably because the mass of materials was obtained from the mountains, the greater part of which was precipitated along or near its western shores. In Nebraska, Kansas and Dakota, towards the east, the Pliocene beds become thinner, until they run out entirely. It is certain, however, that originally they were much thicker than at present. Being the upper rocks at the time, they must have been subjected to an enormous amount of erosion during the subsequent Quaternary age. The monuments of this erosion are still visible in many places.

Perhaps the most remarkable monument of the original level of the Pliocene in Nebraska is at Scott's Bluffs and at Chimney Rock, on the

North Platte. These have long been noted landmarks. The country is here crowded into many forms, exhibiting some of the peculiar natural architecture of the Bad Lands. Chimney Rock is about 150 feet high. The strata here and at Scott's Bluffs are horizontal, and therefore the general level of the country must have been as elevated, at least, as the top of these crags.

At Chalk Bluffs the line of separation between the Miocene and Pliocene is 6,000 feet above the sea level. Near 41° 30min. the Pliocene reaches an altitude of over 7,000 feet. In the valley of the Loup Fork the contact plane between the Miocene and Pliocene approximates to 3,000 feet. There is, therefore, a gradual sinking eastward of the contact plane between the Miocene and Pliocene.

Near the mountains the materials of the Pliocene beds are exceedingly coarse, and where they are in contact with the foot-hills they are composed of conglomerates made up of water-worn pebbles, feldspar and quartz, in masses, and some small pieces or chips of all the Archæan rocks which are represented towards the west. The fragments are of all sizes, from a shot to a man's head, and even larger. The coarser conglomerates form the upper beds, beneath which there are often much finer materials. The erosion of the upper strata has in many places cut through the coarse conglomerates and widened the bed below the finer ediments, producing over-hanging rocks. Beautiful illustrations of this kind of erosion can be seen along the streams flowing eastward from the Laramie Hills. South of the Union Pacific Railroad, west of Cheyenne, the Pliocene beds form irregular terraces, which often change, or are prolonged into curious sharp escarpments. South of Cheyenne and eastward, the upper beds are often made up of light, creamy limestone, sometimes exceedingly brittle, intercalated with small veins of chalcedony. Still further eastward, north and south of the Union Pacific Railway, the Pliocene beds become arenaceous, but fine-grained, beds of clay and marl being interlaminated. The Chugwater is bordered for a long distance with abrupt cliffs of Pliocene rocks, often forming escarpments which have been cut out by lateral ravines and small canyons. At Scott's Bluffs, near the western line of Nebraska, there is a fine exposure of the Pliocene rocks, which are here made up of sandstones, marls and whitish and yellowish white clays. Along Lodge Pole Creek the Pliocene rocks have assumed more the forms of bluffs. Here, and occasionally on the upper Republican, the thin, marly members sometimes contain thin masses of jasper like rocks, which occasionally contain dendritic markings, produced by oxides of the metals. Among these, moss agates are occasionally found.

South of the Republican Valley, in Nebraska, on the Driftwood, there are some fine exposures of the Pliocene. The following section, which I took in the spring of 1876, is from township 1 north and 32 west, and on sections 12 and 14. It is numbered from the top:

	Feet.
1. Loosely compacted sand and pebbles, with ebb and flow structure,	10
2. Alternations of greenish and gray marls	14
3. Soft concretionary limestone	8
4. Sandy marl	10
5. Soft concretionary limestone	6
6. Soft limestone and marl	4
7. Silicious limestone, with pockets and concretions of pure white lime	14
Total	55

The strata in all these sections vary much, even within a quarter of a mile, and sometimes within a hundred yards. The least variation is observed in the green marl beds. The section on the Driftwood is quite different from the ones on the Loup and Niobrara. On the south side of the Republican, in Harlan county, the Pliocene rests on the Niobrara Cretaceous. From Harlan county to the west line of the State, along the Republican valley, the rocky bluffs of the valley are made up of a silicious limestone, which often shades into a fine and then coarse conglomerate. Pliocene thins out towards the upper end of the valley, and near the State line, in places where it overlies the Fort Pierre Cretaceous, is only from twenty-five to sixty feet thick.

One of the most remarkable of all the deposits of this Plocene lake of the plains is a peculiar flour-like material that appears in beds of greater or less thickness and extent, that occurs on the Republican, the Loup, Niobrara and other sections. When I first examined it under the microscope, eight years ago, a few diatoms were collected, from which circumstance it was regarded as probably of the character of tripoli. Since then, in many specimens that have come under my observation, a diatom has rarely been found. In almost every specimen examined, however, great numbers of the forms that Ehrenberg called Phytolitharia were detected. The most conspicuous of these are triangular in shape, with one edge convex and the other concave, or the opposite. They cover, under a microscope magnifying 90,000 times, or 300 diameters, the space of about one-eight of an inch, and of incalculable thinness. These specimens, under such high powers, are translucent. Many other curious microscopic forms occur. The chemical analysis of this earth, however,

is very different from tripoli. It is proved to be a silicate of the alkaline earths, and most generally of soda, potash, magnesia or lime. Sometimes only one and sometimes several of these alkalies are present. It ranges in color from light gray to snow white, green and yellowish. All these colors are sometimes found in the same bed, and the chemical composition varies even more than the color. To the touch it feels very much like flour. The best specimens have no grit, and when used as a polishing powder no scratches can be detected even with the microscope. It is most abundant along the Republican, where it is found in almost every county."

These deposits have a most interesting history. No chemist, however subtle or learned, can properly portray the play of mysterious forces deep down in these boiling cauldrons of superheated waters; nor can he, except in a rude way, imitate the compounds that have been thus contributed to the surface from the earth's interior. They extend from Johnson county west, through Gage, Thayer, Webster, Franklin, Harlan, Furnas and Red Willow counties, in which they are found in pockets of various dimensions, often containing many thousands of tons. I have noticed that the coarser varieties are in the eastern counties. Some silicate deposits near the Colorado line are the finest that have ever been discovered. In the samples here presented the grains or crystals are so minute that 2,400,000,000,000 of particles are required to make one cubic inch. This is a degree of fineness far beyond Ehrenberg's estimate of the "Bilin" or Tripoli of Germany. He found that this remarkable deposit of the siliceous shields of animalculae contained forty billions—that is, each of them was six hundred times the size of these specimens. It would require for a person to count the grains or crystals of one cubic inch over 500 years. One of the largest and most interesting of these deposits is near Arapahoe, Furnas county. It appears as a bed, or stratum, fifteen or twenty feet in thickness, and of indefinite width and length. It is worthy of notice that the deposits have a western exposure—that is, they front to the west, in canyons or valleys. They have an extent north and south of from one to two miles. These facts have suggested

that the geysers in whose hot water they doubtless originated, were not spouting hot springs, but were possessed of side openings or clefts through which the super-heated waters on cooling left these alkaline crystals in their present semi-solid form. It would appear also that different degrees of heat and pressure, varying with the depth of the geyser sources, will, as a theory, account for the finer or coarser crystals of the various beds or deposits. It will be observed that these crystals under the microscope, are transparent; they are sometimes stained by an oxide, but are otherwise transparent like glass. The reason that, in mass, the appearance is gray or drab, is that in this form, like pounded glass, the refraction is constantly broken. Its appearance is therefore a mingling of light and shade, or iron gray or neutral colors. The exceeding thinness or tenuity of these crystals opens a new door to inquiries concerning the origin of crystaline masses.

The Ancient Geysers of Nebraska.

It is a fact known to scarcely a dozen persons that there exists in Southern Nebraska a series of hot springs, or geysers, whose ebullition ceased ages ago, but which have left unmistakable proof of their existence in the vast mounds of deposits in the center of which are still visible the deep tubes or wells through which the hot and steaming waters were forced upward to their overflow. My attention has just been called to these deposits on Rose Creek, south of Fairbury, in Jefferson county. They consist of almost pure silica tinged yellow with chromate of iron. In that region solid masses of this material are found occupying many hundreds of acres. By many they are called ledges of iron, to which they bear a very close resemblance. The same rock is also found in the southwestern part of Saline county. Its composition is hard and glossy. It breaks easily in any direction, and divides into horizontal layers. It can and will be made very useful in building material, as it will endure both exposure and pressure.

One of the most notable and best defined of these extinct geysers, after leaving the geyser deposits in Jefferson county, is "Lookout Mountain," about nine miles southwest of Riverton, near the Kansas border. It is a high elevation on the great divide south of the Republican river. The common soil, or loess, covers it nearly to the summit, leaving 25 or 30 feet of exposed rock. This rock is loose and spongy and nearly white, the prevailing shade of the usual soda and magnesia formations. The crown or top is circular, with rough edges, from which broken masses have fallen to make up the debris upon the sloping sides below. From the south the peak is covered with soil to the summit, permitting a wagon road to the common level of the divide. This is a geyser chimney, based far down upon the rocky substratum, and built ages ago by the usual forces, physical and chemical, that accompany active geysers, or hot springs, on an extensive scale. It is perhaps 150 feet to the solid rock upon which the hot alkaline water, through a fissure or crevice, began their overflow, and consequent deposit. These deposits, from their great quantity and coarsness, indicate enormous and continuous discharges of hot alkaline waters, escaping in the direction of lower levels until accumulation by precipitates turned the overflow aside or in an opposite direction.

The next locality visited was ten miles southwest of Red Cloud in the Republican Valley. It comprised hundreds of huge fragments of grained rock, weighing from five to twenty tons each, and so disposed in the hillside and ravines as to lead to the impression that here is a huge granite quarry.

Southwest of Republican City tourteen miles, on Prairie Dog creek, is found the largest of these singular deposits. They are naturally called "Granite Bluffs" from their close resemblance to the lighter varieties of gray granite, and it is not easy to change the popular verdict that this is a veritable granite formation. It is a bold bluff of solid rock, rising almost abruptly to a height of eighty feet on the east, with less precipitate rise toward the north, on which side it is exposed in a circle nearly

a mile and a half in extent. Fragments, large and small, are distributed around the base, mainly due to the breaking and crushing power of the glacial agency. The creek makes a circuit of seven miles, and renders the rocky area almost an island, showing that it existed as an isolated mountain of rock before the valley of the creek was established; and when this watercourse of the glacial area was established the dome of "granite" as it was called, compelled the stream and valley to make here a grand detour.

The rock contains silica, soda, potassa and iron, with but little lime or magnesia. It is very hard and brittle, easily breaking into straight lines of any required size. It is good for almost any use that may be required of it—none of the disintegrating forces having scarcely any effect upon it. It will serve for foundations of all structures or superstructures—for the railway, the city or the common house. The farmers of Kansas haul the loose fragments many miles, indicating the uses as above described. The material is homogeneous throughout, leading to the theory that it is the result of one, instead of a series of hot springs, whose periodic overflow has, during long ages, deposited these alkali rocks.

The central chimney or tube through which the waters once holding these rocks in solution, were conveyed, will probably be found from one to two miles south of the northern curve of the bluffs.

Twelve miles south of Republican City is another of these elevated craters. It is a large conical hill several hundred feet in circumference. Its altitude above the Republican river is nearly 250 feet, having the appearance of an extinct volcano. Within the rim and covered with the debris of centuries, are found the remains of huge mammoths, the mastodon and other extinct races of animals. Large quantities of these bones have been exhumed from this walled inclosure. One, a femur-bone, was six feet in length and ten inches in diameter at the joint, indicating a monster of fifteen or sixteen feet in height. The

curved socket-bone shows a diameter of ten or eleven inches. Many of these remains have not been determined.

The locality is known as the "Big Bone Mound." These animals, when alive, sought this place to drink of the saline waters then flowing from this geyser, and, venturing in too far, perished, leaving their skeletons, teeth and tusks as proofs of their existence.

Another of these remarkable formations is found in Harlan county, two miles south of the residence of Judge Robbins, on the divide between the Sappa and Prairie Dog. It is also conical in form with straight sides sloping at an angle of 22½ degrees nearly. Its diameter at the summit is perhaps 500 feet. The edge, or rim, is a natural stockade, and is a composition of lime, soda and magnesia. In the center the rock is coarse and spongy, filling up the central chimney or tube, and partly concealing it from view. By the long action of frost and rains this rock has crumbled into fine fragments, rendering the summit-area nearly level. It has for centuries been a land mark used by Indian tribes in their marches north and south across the plains. One of their signals can be found there to-day, consisting of a hundred or more pieces of rock arranged in the form of a man on the ground, with face, hands and feet set to the north. It is a rude sign indicating to some savage tribe that their comrades were on their winding way. Whether pursued or pursuers they have long since vanished, leaving behind them no enduring mark save this.

To many this will appear as an assumption, or "begging of the question," that this or the foregoing instances are the results of geysers, or hot springs. But we can examine one of these springs in actual operation near Cawker City, in Mitchell county, Kansas, thirty miles south of the Nebraska line. The noted spring is called "Manitou" or "Great Spirit" spring—so named by the Indians who from time immemorial have here held their meetings, with song and dance and such other incantations as relate to their "big medicine" business. It is a huge stone basin,

near 500 feet across the top. In the center is a circular pond of warm water, which pours over the rim of the basin and escapes to the Solomon river, near by. The water is alkaline, salt being predominant. Attempts to find the depth of this circular boiling spring have not been successful. It probably extends downward several thousand feet, and communicates by cleft or fissure with the thermal waters, warmed by the interior heat of the earth.

The great mass of rock enclosing these briny waters is about seventy feet above the Solomon river. It appears to be the summit of a chimney built up from unknown depths by deposits from the overflow of this alkaline spring. The rock is a concrete of lime, magnesia, silica and potassa, which are all soluble in hot water, and which will precipitate on cooling. For ages these waters, saturated with the above materials, have risen by subterranean force, and deposited layer after layer of this composite rock, thus silently building these huge walls to their present height, when the force gradually ceased, and the work is now nearly stopped.

Still further southwest, on the same divide, in Philips county, are the craters of two more ancient geysers, one of which is called "Bread Bowl Mound," from a close resemblance to that antiquated article. It has nearly the same height as those already described. Its width at the base is not far from 1,500 feet, sloping rapidly to the top, with an area of perhaps 400 feet. The evidence of the crater and overflow are most convincing to the chemist and geologist, and will not fail to convince the ordinary observer. Most of these closed craters give a hollow sound, and all of them present a series of deposits from alkaline solutions, permitting of no other theory.

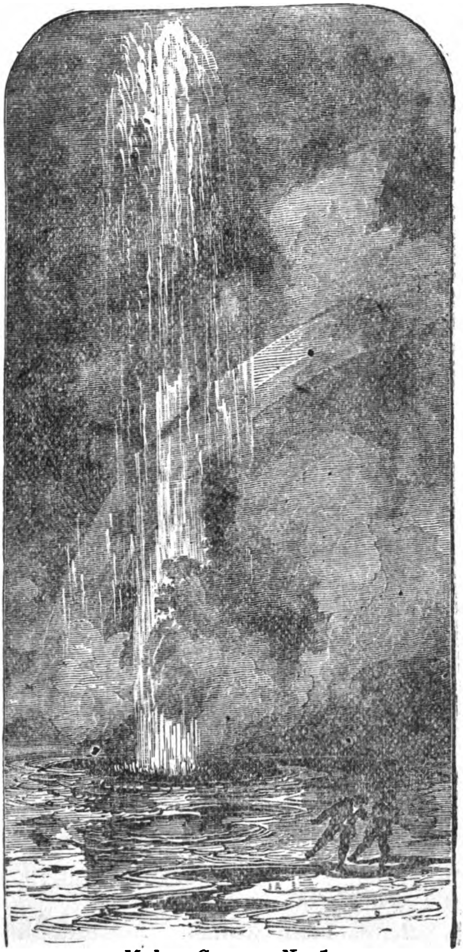
But the most convincing proof was shown in the series of natural wells about two and one half miles northwest of Norton Center, in Norton county, Kansas, twelve miles south of the Nebraska line. These wells or tubes are two or three feet in diameter and of great depth. They are lined with a hard crust of

lime and magnesia an inch thick, made firm and strong by continuous deposits at each overflow. The "made rock" extends over several acres, in which several of these ancient wells have been found. They are now filled with water quite free from all saline matter, the water from two of them being used for domestic purposes. One of them has been named the "Wilber Well." It is most gratifying to know that there is in this country an object bearing my name suggestive of pure, cold water. Here in plain view are thousands of tons of alkaline rock, and the tubes through which the now hardened material was long ago conducted in a hot fluid state and on cooling precipitated and became solid, as we see.

Other instances of ancient geysers are found to the west and north, and which are probably connected with the Yellowstone country, where these boiling springs exist to-day on a large scale, in active operation.

Regarding the foregoing elevations as craters of extinct geysers, which from their great height now appear above the surrounding country, and are now used as land-marks by travelers, and formerly as lookouts or signal stations by Indian tribes, it is rational to suppose that these tall chimney tops, in all not exceeding fifty in number in both Nebraska and Kansas, are but few in comparison to the number of extinct geysers whose tops are covered with the subsequent deposit of the loess, or other formations. It is quite probable that thermal waters charged with alkaline earths, in solution, and forced upward by steam from contact with super-heated rocks deep in the interior, have borne a most important part in the geological history of the Republican valley.

The vast beds of geyserite occupying several miles in extent, overlying the general base rock like lava beds; the numberless deposits of greater or less extent of silicates of soda, potassa and magnesia, with frequent deposits of carbonates of lime, soda, magnesia and potassa, in constantly changing proportions and shades of color, and beside, in every form, from solid amorphous



Modern Geysers.—No. 1.

GRAND GEYSER, YELLOWSTONE PARK.

masses and closely laid strata, like the leaves of a book, to the finest granulated crystals—these results, seen everywhere in profusion, over made areas along the 40th parallel, indicate unmistakably a great activity, during a long period of time, of semi-volcanic agency, of water eruptions on a grander scale than we from our limited comparison can conceive.

The Yellowstone park scenery, as a whole, is too grand, its scope too immense, its details too varied and minute to admit of adequate description save by some great writer, who with mind and pen equally trained, could seize upon the salient points, and with just discrimination throw into proper relief the varied features of mingled grandeur, wonder and beauty.

The Mammoth Hot Springs are the first point of interest in the park. They occupy a small valley, discharging eastward into that of Gardiner's River, which the spring deposits have partly filled. Above our camp arose the extinct spring, so called from the shape of the mausoleum which it had itself constructed. The "Liberty Cap" or "Giant's Thumb," and beyond this again a succession of terraces, rising to the height of some 200 feet, dazzling white in the sun, indicated the presence of the active springs, which indeed had all along been evident enough from the vast clouds of vapor continually arising. The terrace exhibited great variety and beauty of form, much enhanced by the quivering and sheering effects of the descending sheets of water.

The material is carbonate of lime, deposited by the cooling of the waters, of a nearly pure white, and, while wet, of moderate hardness. Upon drying the deposit becomes soft and pliable, and a hunting knife could be easily plunged into it. The main springs occupy the upper portion of the terrace, and spread into large limpid pools of a superb blue tint, boiling violently in places, and emitting clouds of steam.

Overflowing the pools the waters escape down the face of the terraces, and in cooling gradually part with the carbonate held in solution, making constant addition to the ornamentation of

GIANTESS GEYSER IN ERUPTION.

Modern Geysers.—No. 2.

15

the surfaces and constructing scalloped pools and "bath tubs" of every form and temperature. The whole vicinity to the springs returns a hollow echo to the tread, highly suggestive of pit-falls beneath. Remains of extinct springs abound above and below the active ones, while others in full flow exist near the river's edge.

It was during the Pliocene period of the Tertiary epoch, now under consideration, that the system of geysers attained their greatest activity. It is also evident from the great number of geyser pipes, or chimneys, appearing on the surface of all rock formations above the upper carboniferous that the era or period of hot springs must have been of great duration. It is also evident from the vast amount of geyser products indicated in the foregoing pages, that it has been one of the most active and extensive of the geologic forces or agencies. And because its products are constantly the alkaline earths, viz: Silica, alumina, soda, potassa and lime, in varying proportions, and because these materials are increasing as we approach the close of the tertiary period, it is fairly inferred that the great loess formation has its origin in the sediments, or precipitates, of loess that were made still more alkaline by the constant eruption and outpouring of numberless hot springs, active and powerful, over all the area now covered by the loess deposits; but as I have already proposed this theory in treating of the loess formation in chapter 3rd, it need not in this work receive further consideration.

In the lower beds of the Nebraska, Pliocene are found in many places, and especially on the Niobrara many remains of coniferous trees. Among these are petrified wood, bones and leaves. It is possible that some of the petrified wood may have been derived from older formations. If not, then there flourished during these times at least one araucarian pine. A flake from an agatized specimen which I obtained from the Niobrara, under the microscope gave distinctly the structure of the araucarians. There is no such doubt about the common pine family, as both cones and leaves of these are preserved. On the Niobrara, in the lower beds of the Pliocene, occur, at rare intervals, palm-like leaf remains, which probably belonged to some species of sabal, though the re-

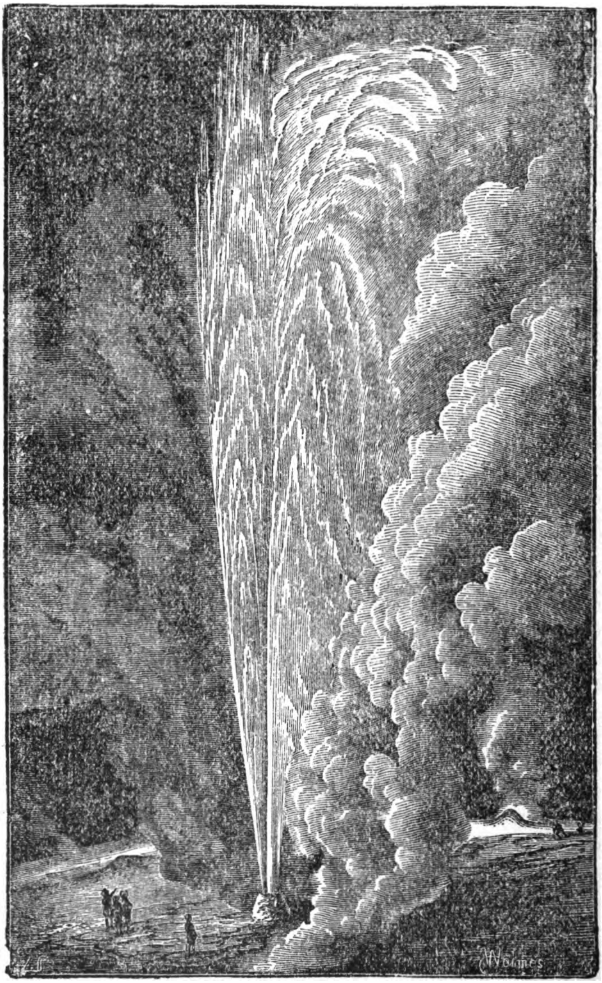
mains were too indistinct to identify. At the same horizon remains of fig leaves occur. In Harlan county, on the south side of the Republican river, occur masses of silicious limestone that are filled with the petrified or semi-petrified seeds of probably some species of Arrow-wood (*Viburnum*) which is a member of our Honeysuckle family, which had its greatest development in Tertiary times. A flora similar to this characterized Europe during this epoch, but it disappeared at the end of the Tertiary. Here, however, our conspicuous vegetable forms are yet Tertiary in type, and almost in species. So far, therefore, as our flora is concerned, America, as has long since been remarked, is the old world.

During this epoch the higher forms of animal life, and especially the mammalian type, had a remarkable development. They must have been exceedingly abundant around the shores of the great lake of the plains, as is evident from the vast number of their remains.

The horse family (*Equidæ*) were represented by at least four genera and fifteen species. The species were comparatively small in size. Hyperion occidentalis, whose remains occur at several horizons and at widely separated localities, was the largest species, but was only about the size of the ass. Three other species, found on the Niobrara, and described by Leidy, were still smaller. The most perfect, at least the most modern of the Pliocene horses of Nebraska, was Equus excelsus. Dr. Hayden first found its remains on the Loup, then on the Niobrara, and then at other points. It was about the size of a medium-sized modern horse, and differed only in trifling details from the present one. I have found its remains in the uppermost Pliocene beds in the Republican Valley and in the Quaternary. It extends over from the Pliocene to interglacial times. This most modern of the Pliocene horses, seems to have been the culminating form of the family in this epoch. It is evident that they must have existed here in Pliocene times in prodigious numbers. In fact, these regions, above any other in any geological age, were dominated by horses.

Tne elephant family (*Proboscidians*) which first became sharply outlined in the preceding Miocene epoch, was represented in the Nebraska Pliocene by at least two genera and species. Mastodon mirificus (wonderful Mastodon) was first described by Leidy from the Pliocene beds on the Loup. Hayden also found its remains in abundance on the Niobrara.

The remains of a gigantic elephant (*Elephas imperator*) was also found by Hayden on the Niobrara, and described by Leidy. It was either distinct from the elephant that appeared afterwards during the Quaternary or else was of larger size. A portion of the femur of what I take to be



Modern Geysers.—No. 3.

FAN GEYSER, YELLOWSTONE PARK.

this species, now in the cabinet of the University, is certainly more robust in form than that of the Quaternary elephants. The remains of other species have been found on the Niobrara and Loup, but have not yet been specifically described. It is evident, therefore, that in Pliocene times elephants and mastodons were abundant over the land surface of Nebraska.

The camel family (*Camelidæ*) were even richer in genera, species, and the number of individuals than during the Miocene. The most characteristic genus was Procamelus, which was represented by at least four species, three of which were described by Leidy. Their remains are found on the Niobrara, Loup and Republican.

Bison already existed in the Pliocene epoch in Nebraska. The progenitors of our buffalo probably then existed in the forms which Marsh has described under the name of Bison Ferox and Bison Alleni.

The cat family (*Felidæ*) had fewer representatives than in the preceding Miocene. Ælurodon ferox was slightly larger than the largest American wolves. One of its sectorial molars, according to Leidy, was intermediate in character between that of the wolves and the cats. "It approached in size the similar molar of a small Bengal tiger. It had the proportion of the similar molar of the wolves, and in addition the anterior accessory lobe of the cats."—LEIDY.

The dog family (*Canidæ*) was much more fully represented than the last, not less than four species having already been described by Leidy. Canis Haydeni was a wolf of much larger size and more robust form than any now in existence. Another species was also slightly larger than any now living. Leidy calls it Canis rarus, and considers it a near relative if not actual progenitor of our present wolf (*Canis accidentalis.*)

From the preceding it is apparent that many forms of mammalian life culminated in the number of species and the size of individuals during the Pliocene epoch. The conditions during those times must have been exceedingly favorable to the development of mammalian life. Not the least remarkable is it that most of those animal forms which are now regarded as most useful to man were the most numerous and best represented during an epoch when, so far as we now certainly know, he had not become an actor on the stage of the world. At least no undoubted monuments of his presence in the world during Pliocene times have been preserved in geological history or tradition. The alleged special servants of man, however, were present during the Pliocene epoch in extraordinary numbers.

Let us now, if we can, form some picture of the character and physical condition of the Tertiary ages. Take, for example, the middle Pliocene.

Had we been in existence then, and started westward on a journey from some point near where the Missouri now flows, much of the peculiar life of the times would have been observed. The climate was congenial in an eminent degree. The great Pliocene lake caused a much moister atmosphere than exists at present. Groves of Sequoias, like the present gigantic trees of California, the glyptostrobus, of China and Japan, the cypress, the date and the palm, were interspersed with magnificent savannas. The songs of ten thousand birds, many of them of the most beautiful plumage, would have greeted our ears. At some places herds of thousands of Oreodons would have been encountered. Bisons, similar in form to our buffaloes, would have been seen cropping the grass. At other points might have been seen herds of elephants and mastodons quietly proceeding towards some streamlet, or lakelet, to indulge in a bath. Vast numbers of many species of camels would have been seen reposing at mid-day on a gentle hill-side under the shade of sequoias or cypress. More curious than all, thousands of Hyperions, those wonderful three-toed horses, along with many kinds of one-toed horses, of all sizes, would sometimes have made the earth tremble under their tread. When, at last, in such a westward journey, the shores of the great Pliocene lake would be reached, its borders would have been a marvel for the life represented there. A rhinoceros might have been seen wallowing in the mud near the shore. Thousands of water-fowl would have been seen riding the gentle waves. Elephants, camels, oredons and horses might have been seen there slaking their thirst in the streamlet flowing into the lake. Life would have been observed everywhere—the hum of insects and the song of birds in the air—life in the trees, in forest and glade, on land and lake.

There is evidence that the Pliocene epoch only gradually came to a close. The lake of the plains was probably partially drained, and a large part of its surface became dry land long before the last centuries of the Pliocene had ended. The eastern border of the great Pliocene rim commenced to descend and gradually left out the water until much of this great lake of the plains became dry land. There is also evidence of increasing cold in the deposits of this lake through their upper sections. The southern shores of the lake were probably rising at the same time, which would help to intensify the growing cold. An ice cap had now formed in polar regions, and conditions of climate similar to the present intervened. Age after age the increasing cold, accompanied by gradual elevation of land towards the north, continued, until finally the Arctic ice cap crept down to our present temperate latitudes. The flora and fauna of the Pliocene migrated southward, and many species and genera

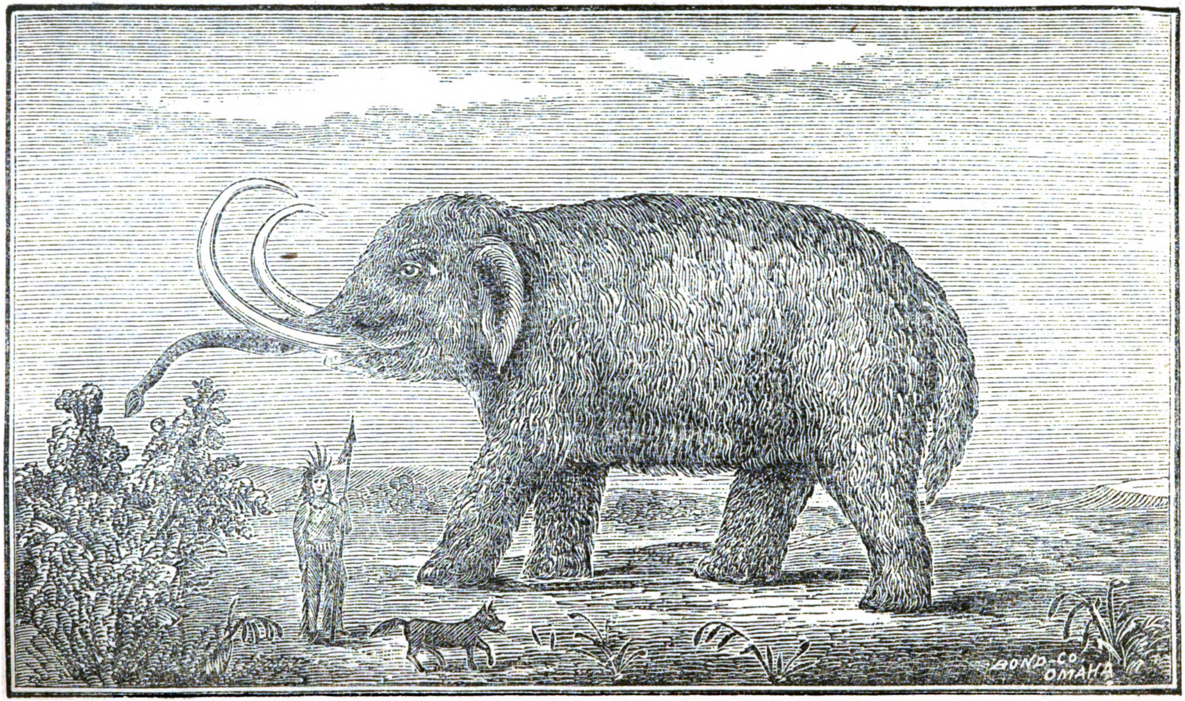
were exterminated. The distinct fauna that made its appearance during the Quaternary originated some time during the transformation of the Pliocene into the glacial epoch.

Mammoth Remains in Nebraska.

It is proper in this connection to refer to the discovery of the remains of the gigantic quadrupeds which have been exhumed within one or two years, not only in Nebraska, but in many of the northern states and territories. The great numbers of skeletons, teeth and tusks found over the continent indicate both an extensive range and many individuals. These remains are abundantly found, not only in the Pliocene-Tertiary formations, but upon the surface or loess formation, in peat swamps, or in the vicinity of salt springs, showing that they did not become extinct during the glacial period, but that they existed contemporaneous with the early races of mankind.

Most notable of these now extinct mammoths is one whose remains were found in Saline county, Nebraska, and which was first described by the writer in a paper read before the Nebraska Academy of Sciences, a portion of which is here introduced:

The remains were found in a depression near Swan Creek, in the southern part of Saline county, and were preserved in a bed of humus, whose antiseptic quality was sufficient to keep them in form. They were, however, very frail from dessication, and easily crumbled on exposure to the air. Eight bushels of bones of the feet were taken out, besides portions of leg bones. One of these, a femur, measured two feet seven inches in length and six inches in diameter. In the modern elephant the corresponding bone measures about twenty-one inches. Portions of the tusks were also taken up. They were much more curved than the tusks of the common elephant, and indicated over ten feet in length and ten inches in diameter at the base. The curvature was not the same in each tusk, owing doubtless to extra pressure from the superincumbent earth. In preparing the drawing for it Mr. L. D. Barker had the drawings and models of specimens of the various museums—St. Petersburg, in Europe, and of



ELEPHAS PRIMIGENIUS, FOUND IN SALINE COUNTY, NEB.—*From a drawing by L. D. Barker.*

Harvard and Rochester, in this country. The animal has been recognized as Elephas Primigenius, by Prof. Aughey, or the earliest of the species. But there are good reasons for E. Americanus. The size of the animal, living, must have been sixteen feet in height and twenty-eight or twenty-nine feet in length, and its weight when in best condition 20,000 to 25,000 pounds. Around its body it would measure thirty feet; its spreading foot was three feet in diameter. A man six feet in height, with high hat, could stand erect beneath the animal's body. It was entirely covered with slightly curled hair five to eight inches long, in this respect differing from the modern elephant. Under the throat grew longer hair, like fringe, of twelve to fifteen inches in length.

Prof. Winchell gives the dimensions of a full mounted mammoth, now in the museum of the University of Rochester, New York. He stands sixteen feet in height; his extreme length is twenty-six feet, and the distance between the tips of his tusks is fourteen feet. His body is thirty feet in circumference close to the skin; the sole of his foot is three feet in diameter; his tusks are fourteen feet long and one foot in diameter at the base; between his short post-like fore legs a man can stand upright with his hat on without touching the animal's body. Regarding this class of monstrous quadrupeds Prof. W. says:

"History has preserved no mention of its existence in a living state, but its bones are scattered over the whole of Europe and Northern Asia as far as Behring's Straits. Even on the Amercan side of the Straits they occur in similar abundance. A somewhat different species of mammoth has left its remains throughout the United States, and even as far as Mexico and Central America. Still another species ranged from Honduras to Peru. Naturalists have designated the first mentioned as the primeval mammoth (elephas primigenus,) and our own species the American Mammoth, (Elephas Americanus. The other species is the Andium Mammoth (Elephas Andium.)

Like modern elephants the mammoth probably delighted in water and mire, and sometimes indulged, like the rhinoceros and well known pig, in the dirty habit of wallowing in the mud. This instinct tempted the huge creatures into treacherous bogs, in which they seem sometimes to have sunk beyond recovery, for their bones are frequently preserved in beds of peat, and the skeleton is occasionally found in an erect position. Their tusks occur in Northern Russia in such abundance as to supply an important part in the ivory of commerce. It is said that Siberian ivory constitutes the principal material on which Russian ivory-turners work. Alaska also affords considerable supplies.

The sudden disappearance of the mammoth tribes, whose remains are so abundant as to indicate that they existed in great numbers, has caused several conjectures, or theories, regarding the cause of their exit. Prof. Aughey says they became so numerous in the Nebraska and Upper Missouri region that the primitive race of man combined in armed forces, and utterly destroyed them. He cites the fact of arrows found beneath their huge bodies as proof of contemporaneous existence, but no data can be given concerning the actual chronology of either. It is not probable, however, that the great length of time usually prescribed by a certain class of naturaliste, is really required in order to satisfy the reasonable judgment in comparing cause and effect.

It appears, however, that in northern latitudes their exodus was hastened by the coming on and continuance of the great ice age, called sometimes the last glacial period.

Dr. Edmund Andrews says: "These great animals were very abundant around the head of Lake Michigan a few thousand years ago. They had a proboscis, and as they roamed the woods looked exactly like elephants, except that the forehead sloped more backward, and the body was somewhat longer in proportion to the height. They were rather larger than modern elephants. It is not known whether they had hair like the Siberian mammoth. The American mastodon had no very enor-

mous antiquity. The black underground peat bed in which the Chicago skeleton lay, is a very wide-spread deposit, and has such relations to the rate of erosion of the lake shores and of beach formation, that its age has been approximately determined. The animal was alive at a period not less than four thousand and not over ten thousand years ago. It belongs to the period of the earliest known relics of men. There are in India and elsewhere other species of mastodons belonging to the tertiary period, which are older; but the American mastodon, the American and European mammoths, and the two or three European rhinoceroses were probably contemporaneous with each other and with the earliest men. A great deal of nonsense has been written in the name of science to give an exaggerated idea of their antiquity; but after wading laboriously through the whole subject, I give my opinion without hesitation that these animals lived at a period only a few thousand years prior to our own times. The total number of mastodon species known is about eight, and there have been discovered perhaps ten or more species of elephants. The mastodons are all extinct. Of the elephants only two species survive. It is a difficult question as to why they perished, since they were too formidable to be destroyed by beasts of prey and lived in regions full of their favorite food."

The writer just referred to, Winchell, is of the opinion that the geological events which have taken place since the epoch of general glaciation do not demand over 10,000 years, and he thinks that the pluvial epoch of Western Europe may correspond with those cataclysms of Europe and Western Asia known as the deluges of Ogyges, Deucalion and Noah, and perhaps of the Great Yu, in China.

That the climate in which they had lived was not tropical, like that of Africa or India. may be regarded as proved by the presence of the fur in which these animals were clothed. That it was not similar to the existing climate of Northern Siberia is apparent from the consideration that such a climate would not

yield the requisite supply of vegetation to sustain their existence. More especially would forest vegetation be wanting, which seems to have been designed as the main reliance for probiscidians. Northern Siberia must therefore have possessed a temperate climate. If the change to an arctic climate had been gradual, the herds of mammoths would probably have slowly migrated southward: or, if no actual migration occured, the extinction of the mammoth population would have been distributed over many years' and the destruction of individuals would have taken place at temperatures which were still insufficiently rigorous to preserve their carcasses for a hundred ages. Whole herds of mammoths must have been overwhelmed by a sudden invasion of arctic weather. Some secular change produced an unprecedented precipitation of snow. We may imagine elephantine communities huddled together in the sheltering valleys and in the deep defiles of the rivers, where, on previous occasions, they had found that protection which carried them safely through wintry storms. But now the snow-fall found no pause. Like cattle overwhelmed in the gorges of Montana, the mammoths were rapidly buried. By precipitation and by drifting fifty feet of snow, perhaps, accumulated above them. They must perish, and with the sudden change in the climate, their shroud of snow would remain wrapped about them through all the mildness of the ensuing summer. The fleecy snow would become granular; it would be *neve firu*, as in the glacier sources of the Alps. It would finally become solid ice—compact, clear, and sea-green in its limpid depths. It would be a glacier; and so it would travel down the gorges, down the valleys toward the frozen ocean, sweeping buried mammoths bodily in its resistless stream. Thus in the course of ages their mummied forms would reach a latitude more northern than that in which they had been inhumed. It may even have been the case that living mammoths lingered in the country which had witnessed the snowy burial of herds of their fellows. Some must have escaped the first great snow-deluge, and there must have been

a return of sunny days, during which they could seek to resuscitate their famished bodies; and spring must have come back at last, and another hope-inspiring summer—cheering but illusory. And if a secular pause in the severity of the climate ensued, a few survivors may have lingered for many years. But winter, dire and permanent, was on the march, and the record which it has left declares that the mammoth population struggled in vain against the despotism of frost, and that the empire which was set up has crumbled only under the attacks of many thousand summers."

Geological evidences of a great and somewhat sudden change of climate throughout the north temperate zone, in times geologically recent, are too familiar to require more than a mere mention. The greater part of Europe and all North America to the latitude of 36° were once buried beneath sheets of glacier ice. In Europe we have evidence of the presence of man while the continental glaciers were flooding the rivers of France by their rapid dissolution. At the same time the mammoth was there. While thousands of his fellow-mammoths were lying stiff and stark in the icy cemeteries of the North, a few of the giants of a former age had chanced to dwell in latitudes which perpetual snow had not invaded. These were a part of the game which the primeval inhabitants of Europe pursued. Of his ivory they made handles for their implements and weapons. On his ivory they etched figures of the maned and shaggy proboscidian, of which neither history nor tradition has preserved the memory. The bones and teeth of the mammoth are strewn through all the cavern homes and sequestered haunts of the oldest tribes who hunted and fought upon the plains and along the valleys of Europe."

In exhuming mammoth remains on one occasion, Prof. Aughey states that he found an Indian arrow-head directly beneath the skeleton—a clear proof that the mammoth and certain primitive tribes were contemporaneous. This statement also strengthens the testimony of Dr. Koch, who became noted

forty years ago in supplying foreign museums with remains of mammoths and mastodons from American localities. He states that in 1839 he dug up in the bottom lands of the Bourbeuse river, in Missouri, from a depth of eight or nine feet, the bones of a mastodon in such juxtaposition with human relics as to show that man and this beast, whose race is no longer in existence, met upon that spot in deadly hostility. The great bones were found erect, as if the creature had become immovably mired in the deep and tenaceous clay. Around it had been kindled a fire by human hands, and in the ashes that lay around the skeleton were scattered bits of charred wood and half burnt bones, stone arrow heads, stone axes and rough stones. All these missiles had evidently been hurled at the creature whose gigantic strength, stimulated by pain, and rage, and fear, the torments of the flames, the shouts of the pursuers, the sharp wounds from their stone weapons, was not enough to extricate him from the slough into which his great weight had sunk him. This discovery presents a picture of a pre-historic hunt on this continent, vivid enough to appeal to the dullest imagination, and more remarkable than any similar incident yet found anywhere else. If here, as elsewhere, there were races (of men) more ancient than has hitherto been supposed, we can no longer look upon the Western hemisphere as solitary and unpeopled, unknown and useless to man, till he, grown old in the East, was numerous enough and far enough advanced in intelligence and wants to wander abroad upon the face of the earth in seaach of a new home.

The Quaternary Epoch.

The Quaternary division comprises that extensive assortment of materials which have been eroded or abraded from all previous formations, and which have been strewn apparently without order or system, everywhere over the solid or rocky strata beneath. By these agencies operating through many centuries, the lofty mountains have lowered their summits, and the great plains have been raised to a higher grade; deep gorges and can-

yons have been filled, and vast areas of barren rock have been overlaid with the fertile debris of ages.

Considering the nature of the work to be done, it is impossible to conceive of any combination of forces less than the tremendous enginery of glacial action that would be adequate to the task of covering the rocky substrata of the earth's surface with its outer, or Quaternary fold of loose material or soil, the basis of the farm or garden. It was the grandest problem of geological history. The making of a world habitable by humanity is involved in it.

The leading feature, however, of the Quaternary formation—the loess deposits of Nebraska—has been already treated in a foregoing chapter. Frequent reference to the Alluvium in connection with valleys and river systems, considered in this volume, renders further discussion unnecessary. It seems most appropriate, however, to conclude the Physical history of Nebraska and the Northwest with a series of reviews, or condensed lessons, in a form convenient for use or reference.

SYSTEMATIC STUDY OF NEBRASKA
IN
A Series of Outline Lessons Arranged for Schools.

I. Geographical Position.

I. Geographical Position of Nebraska.

- I. Latitude, 40th and 43d Parallel, N.
- II. Longitude, 95 deg. 30 min., and 104 W. from Greenwich.
- III. Lat. and Long. of Notch., 40 and 41 N., 102 and 104 W.
- IV. Boundaries, Area, Square Miles.
- V. Climate.
- VI. Products.
- VII. Commerce.
- VIII. Civilization and Law of Emigration.

II. TOPOGRAPHY.

II. Topography of Nebraska.

- I. ALTITUDES.
  - 1.—ABOVE SEA LEVEL.
  - 2.—ABOVE LOWEST POINT.
  - 3.—COMPARATIVE HEIGHTS.
- II. CLASSES OF SURFACE.
  - 1.—DRAWS.
  - 2.—BREAKS.
  - 3.—RAVINES.
  - 4.—CANYONS.
  - 5.—BOTTOMS, OR FLOOD PLAINS.
  - 6.—TERRACES.
  - 7.—PRAIRIES—2 KINDS—ORIGIN OF.
  - 8.—TIMBER.
- III. LIST OF ELEVATIONS.
  - See Pages ——— .
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IV.

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  - Ft. Pierre.
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ERAS.		AGES.	PERIODS.	STRATA.
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CENOZOIC.		AGE OF MAMMALS.	Quaternary.	Terraces. Beaches. Loess. Iceberg Drift Forest Red. Glacial Drift. Champlain Clay. Blue Clay.
			Tertiary.	Pliocene. Miocene. Eocene. (Wanting.)
MESOZOIC.	Age of Cycads.	AGE OF REPTILES.	Cretaceous.	Ft. Pierre Group Niobrara Group. Ft. Benton Gr'p. Dakota Group.
			Jurassic.	Wanting.
			Triassic.	Wanting.
PALÆOZOIC.	Age of Acrogens.	CARBONIFEROUS, OR AGE OF COAL PLANTS AND AMPHIBIANS.	Permian.	Permian Dolomites Permo Carbonifer's
			Carboniferous.	Upper Coal Meas.
			Sub Carboniferous.	
		DEVONIAN, OR AGE OF FISHES.	Catskill.	
			Chemung.	
			Hamilton.	
			Corniferous.	
			Oriskany.	
	Age of Algæ.	SILURIAN, OR AGE OF MOLLUSKS.	Upper Silurian: Helderberg.	
			Upper Silurian: Salina.	
			Upper Silurian: Niagara.	
			Lower Silurian: Hudson.	
			Lower Silurian: Trenton.	
			Lower Silurian: Calciferous.	
			Lower Silurian: Primordial.	
EOZOIC.		EOZOIC.	Eozoic.	

CHAPTER XI

THE GREAT PLATTE VALLEY AND ITS TRIBUTARIES.

The Elkhorn and Loups; The Niobrara River and Valley. Logan, Bow, Blue and Nemaha Rivers—The Missouri River.

THE PLATTE RIVER

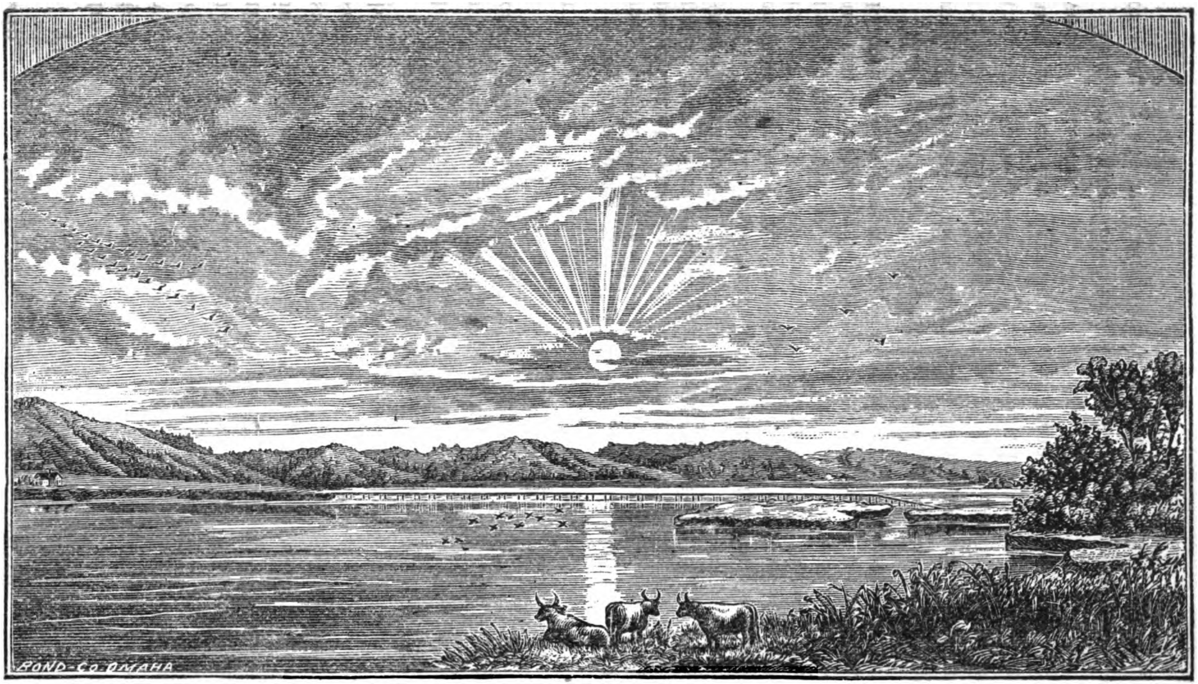
COURSES through Nebraska from west to east, and makes of the State two natural divisions, called respectively the North and South Platte. The original name of this stream was Nebraska, which was afterward given to the Territory, and finally adopted by the State. It signifies wide-flowing water, or literally Ne-bras-ka-water-wide-flowing, which is in itself the most complete description possible. It is a wide, shallow, rapid stream of water, making its way over and through a vast pathway of sands, the product of ages of transportation. From the average altitude of its course, being within the limits of Nebraska 300 feet higher than the main stream of the Republican river (see Chapters I & II) it would seem that its course had been pre-determined by a pre-existent topography, and that it is not like the Republican, the result of glacial action based upon the Rocky Mountain system.

It has not only this great descent going southward over the divide, but also a considerable descent from North Platte to the Niobrara, in a general direction, north and east. The area drained by the Platte and its upper tributaries comprises a large portion of the eastern slope of the Rocky Mountains. The two branches, North and South Platte, uniting the smaller streams of the mountains, converge at North Platte, 290 miles west of Omaha.

From their junction to the Missouri river at Plattsmouth the Platte assumes the broad shallow type, or character, in which its present name originated.

Of its subjacent sands much has been written, showing not only their great extent and depth, but also their connection with a general system of underlying sands and gravel, especially in the southern and eastern portions of Nebraska.

A recent drawing by Mr. Watson, of Fairbury, from the survey of the St. Joe & Denver branch of the U. P. Railway shows that in every well from Kearney to Davenport, a distance of seventy-five miles, water was reached at precisely the same depth, making allowance for the difference of surface elevation. As before stated, the river bed and adjacent bottoms of the Republican are lower than those of the Platte, by a measured altitude of 270 feet, more or less, according to the varying levels or rapids of each stream. It also appears from many facts that the sands over which the Platte rolls its waters are not only deep—from fifty to one hundred feet—but they also have a lateral extent of many miles, underlying the subsoil, and reaching so far beyond the divide of the Republican Valley, where this great sand deposit is reached by ravines or draws. Springs of pure water occur in great numbers. These springs thus originating in the subterranean sands of the Platte, and sustained by its percolating waters, are so numerous that one thousand have been counted in twenty miles distance. This peculiar and most interesting phenomena is of course most conspicuous on the north side of the Republican. The belt of springs and spring creeks is limited in width, and varies from fifteen to thirty miles; but within these limits, for a distance of more than 250 miles there are doubtless more springs, large and small, than can be found in any similar area. In the larger sub valleys these springs unite and form powerful millstreams, whose unvarying flow, during all seasons of the year, not only proves their source to be independent of rainfall, but renders them of great value in an economical point of view.



PLATTE RIVER; NORTH BEND, DODGE COUNTY, NEBRASKA.

The first terrace or bottom lands of the Platte, vary in width from six to fifteen miles. These vast expanses are so uniform as to give the appearance of table lands or p ains, instead of a river valley. The inclines are always on the north side, with abrupt cliffs or bluffs on the south side. This line of ascent, from the river northward, measured anywhere between the mountains and the Missouri river, is an even gradual slope, often of many miles in length before it reaches the distant divide; but on the south side of the stream the bluffs and broken land begin at once, sometimes leaving a broken strip of one to two miles in width before merging in the high rolling prairie beyond.

An investigation of the physical causes resulting in this peculiar topography would lead us to consider the causes of glacier motion in the general direction—from the northwest to the southeast—a topic beyond our present limits.

Prof. J. E. Todd, of Tabor College, Iowa, who has given much study to this class of physical problems, argues:

"1. From the exceptional course of the Platte, from Kearney to Fremont, and its running so close to its southern watershed between those points, that it formerly flowed down the valley of the Little Blue, and was turned by the formation of an extensive terminal moraine during the second glacial epoch.

"2. From the high terraces between the Platte and the Loup, Shell creek and Maple, corresponding in height with a broad, alluvial valley, running across Saunders county from North Bend to Ashland, he argues that the Platte formerly flowed at a higher level across Saunders county, and that quite recently it broke through the "divide" between it and the Elkhorn and Fremont, and rapidly cut down to its present level."

The Platte river bottoms or flood plains are probably the most extensive of all western alluvial formations. Limited on the south by the persistent barrier of bluffs, they expand toward the north with a rise so gradual that the eye takes in the vast area between the river and the horizon with no ratio of intervening distances.

The soil is modified loess, with an extra proportion of silica or sand. It is well adapted to grasses, corn and other grain.

The proximity of this vast fertile river-plain to the underlying waters, abundant at depths from 6 to 20 feet, clearly designates these lands as most promising and valuable as regards their productive ability. A partial idea of their coming value may be gained from the immense yield of hay, of which many thousands of tons are annually prepared, mainly for Government use. The natural grass crop between Fremont and Grand Island, in 1880, is estimated at over 500,000 tons.

From Cheyenne to Omaha the rate of descent is 10 feet per mile; from Cheyenne to Sidney, 20 feet per mile; from Cheyenne to North Platte, 14 feet per mile.

The Loup Rivers.

The Loups taken as one system of rivers are the most important of the Platte tributaries. The area drained by them comprises nearly 20,000 square miles of territory in the geographical centre of Nebraska. The more important of these streams bear the names, North Loup, Middle Loup, and South Loup.

*"The whole length of the Middle or Main Loup approximates to 250 miles. It rises a little east of the 102d parallel, and fifty miles from the north line of the State. My barometer indicated 3,230 feet above the sea level for this point. There are a great number of small lakes and lakelets. I counted nine within a radius of ten miles. Some of them drain into the Loup. It flows in a southeastern direction until the southeast corner of Howard county is reached, when it turns first a little north of east, and then a little south of east, and unites with the Platte near Columbus, commencing at its lower end on the north side. Its first important tributary is the Beaver, and then Cedar creek, which originally took its name from the Cedar groves along its banks. The North Loup also rises among a cluster of small lakes, a little east of the 101st meridian and forty-five miles from the north line of the State. Here I found a dozen of small lakes within a radius of eight miles, and many of them of great beauty, with water clear as crystal. Calamus creek is the most

*Aughey's Physical Geography and Geology of Nebraska.

important tributary. The entire length of this Loup, until its junction with the Middle Loup is 150 miles. Its general direction is southeast. Perhaps there is no more interesting and beautiful valley in all Nebraska than the North Loup. The water is of crystal clearness, and the fertility of the valley is very great. The scenery is varied. This judgment formed twelve years ago, is more than confirmed since its settlement. Corn and the cereal grains are most successfully produced. Timber and fruit trees are grown with an ease surpassed nowhere in the State.

On the south side the main tributaries are Mud creek and the South Loup. The latter river rises immediately beyond the west boundary of Custer county, and flows in a southeasterly direction into Buffalo county, and then northeast to its junction with the Middle Loup in Howard county. There are a large number of smaller tributaries. The rivers are in places excessively sandy, and quite rapid. The quality of the bottom lands vary more than in other Nebraska valleys. At the ordinary level there is a somewhat sandy loam, rich in humus and of a dark color. In depressions slightly below the level of the former, and often of a cloggy texture, the alkaline soil occurs. Slightly elevated above both these varieties is a coarser sandy soil. These different soils often shade into each other, and again they are sharply outlined. The good soil, however, greatly predominates over the inferior varieties. Very little of the alkaline soil can be called poor. Cultivation permits the water to percolate through it and carry to lower levels the excess of alkaline matter, and much is consumed by the crops that are cultivated, especially in wet seasons. Here, as elsewhere in the State, where these soils occur, a few years of cultivation renders them equal to the best in the State.

The Elkhorn.

The Elkhorn is one of the most beautiful streams of the State. It rises west of Holt and Elkhorn counties. Near its source the valley widens to a very great breadth, and the bluffs bordering

PLATTE RIVER VALLEY, NEAR GRAND ISLAND, NEBRASKA.

it are low and often almost inappreciable. In the region of its source, especially south of the centre of the valley, are a great number of beautiful, small, fresh water lakes. Within a region eighteen by twelve miles square, there are at least twenty of these lakelets, most of which drain into the headwaters of the West Fork of the Elkhorn. It soon becomes in size a respectable stream. In the eastern border of Madison county it receives the North Branch of the Elkhorn, which rises in the southern part of Knox county. Unlike the West Fork, or main branch, it does not originate in a lake region, but in a region of innumerable small springs. The channel is full of water holes, between which the water often in midsummer flows underground. Soon it loses this character and becomes a rapid, clear, deep and beautiful stream. The general direction of the main river approximates to 250 miles. Its direction is southeast. It empties into the Platte in the Western part of Sarpy county. For a large part of its course, the Elkhorn flows over rock, through bottom lands from two to four miles in width, the Elkhorn so constantly meanders, or deviates, as to give nearly 700 miles of stream for the first 200 miles of its course. Its drainage area exceeds 5,000 square miles; its average rate of descent per mile is six and one-half feet, and it is said by those who have carefully surveyed the stream, to have a good mill site for every five miles of its course.

The Logan is the most important tributary of the Elkhorn. It rises principally in Cedar county. Of several branches of this river, it is impossible to tell which is the longest or deserves the name of principal stream. They all originate in bogs or old filled up lake beds. Large beds of peat are here found. After emerging from these bogs, which lie in the midst of the most beautiful and gently rolling lands conceivable, these Logan streams soon become constant, clear, and rapid. The bottoms are pebbly or sandy. There are many of these branches in Wayne County, which through their instrumentality, are among the finest features of any sections of the State. There are nu-

merous smaller tributaries of the Elkhorn, all of which have characters in a minor degree like the parent stream. The general direction of all these Logan rivers is southeast, until Burt county is reached, after which it is south, until a junction is formed with the Elkhorn in the eastern portion of Dodge county.

THE NIOBRARA RIVER AND VALLEY.

The Niobrara river; from its source, in Wyoming, to its mouth, is 460 miles long. Its source, in Wyoming, is 5,100 above the sea level. At the State line it is about ten feet wide, and of beautiful, clear, running water. Its elevation here above the sea level approximates closely to 4,594 feet. It continues to be clear and sparkling, but widening to about fifteen feet down to longitude 103° 15'. From this point it widens rapidly until, in longitude 102° 30', it is from sixty to eighty yards wide. Here it enters a canyon whose walls are high and steep. This canyon region continues down to longitude 99° 20', or about 180 miles. After its emergence from the canyon it is still a broad, rapid, and sandy river to its mouth. Owing to its rapidity and quicksands, it is exceedingly difficult to ford in the lower part of its course. At least, this was my own experience. After sticking fast in the quicksands a few times, and being compelled to take a wagon apart and carry everything to shore, the river loses all romance for the explorer. In the lower part of its course there are many low islands, mostly covered with timber. It flows into the Missouri in range 6 west, and 32 north.

There are numerous tributaries of the Niobrara, most of which are of small size. On the south side, the first of importance is the Verdigris. This beautiful stream, which rises in Antelope county and flows through the west of Knox county, flows into the Niobrara six miles from its mouth. Between this and the mouth of the Key Paha, on the south side, there are a great number of small tributaries. From the mouth of the Keya Paha to the Wazihonska there are also a great number of small tributaries, and the most of these are remarkable for the great number

of fine springs of water which feed them, and for the groves of pine and oak on their narrow bottoms and on their bluffs. The word Wazihonska signifies, in the Dakota language, "the place where the pine extends far out." This stream is about forty-five miles long, and its valley, though much narrower, closely resembles that of the Niobrara. Snake river is the next tributary of importance. Its mouth is near longitude 100° 45'. Its bed is thirty-five yards wide, and it has a narrow valley. Its bluffs are covered with pine. Beyond Snake river there are no large branches coming in from the south.

The Keya Paha is the first large tributary above its mouth on the north side of the Niobrara. It is about 125 miles long. The bed of the river, like that of the Niobrara, is sandy, but its waters are clear, and delicious to the taste. At its mouth it is about fifty-five yards wide. The next tributary from the northwest is Rapid creek, which, however, is only nine yards wide at its mouth. It connects with the Niobrara in longitude 100° 23'. Its valley is in some places half a mile wide, and the soil is, judging from the vegetation, quite fertile. A few small trees fringe its banks. It is about fifty-five miles long. Reunion creek, which flows into the Niobrara at longitude 101° 18', has hardly any bottom, and flows between lofty rock bluffs, very hard to ascend or descend. At its mouth it is fifty-eight yards wide, and has clear, cold, rapid running water.

At longitude 101° 30' a creek flows into the Niobrara, a little more than half the size of Rapid creek, which it closely resembles. Above this there are a great number of small rivulets, which flow into the Niobrara, many of which are dry except in rainy weather. They, however, indicate the former abundance of water here, and will, with the growing moisture and rainfall of the State, again, no, doubt, become permanent fresh water streams.

Agricultural Capacity and Relations of the Niobrara Region.

The greater part of this region has a varied character, compared with southern and eastern Nebraska. In the latter the

PLATTE RIVER, NEAR CENTRAL CITY, NEBRASKA.

almost universal loess of the uplands and alluvium of the bottoms, gives these districts an approximately simple and uniform appearance. In distinction from this the Niobrara and upper Loup regions are marked by some extreme variations. Commencing therefore at the lower Niobrara, the first characteristic lands are what may justly be called chalk soils. They have originated from the decomposition of rock, which here constitute the upper layers of the famous Niobrara group of the cretaceous system. Their chalk origin is not always apparent to a superficial observer, owing to the organic matter near the surface, which has given a dark color to them. In fact they closely resemble the loess where, at the surface, it is mingled with humus. When, however, these soils are closely examined with a spade, the black surface soil gradually shades down into a lighter colored calcareous earth, until finally, at a depth of from one to three feet, decomposed chalk is encountered, and still farther down the solid chalk rock. Chemical analyses also shows that this is its origin. The following are two analyses of these chalk soils, both taken from Knox county, and at a depth of six inches:

	NO. 1.	NO. 2.
Insoluble (silicious) matter	63.100	61.443
Ferric oxide	3 990	4.011
Alumina (clay)	1.075	1.263
Lime Carbonate	22.409	23.847
Lime phosphate	3.812	4.101
Magnesia carbonate	1.328	1.478
Potash	.298	.309
Soda	.170	.194
Organic matter	1.875	1.403
Moisture	1.107	1.008
Loss in analysis	.863	.948
Total	100.000	100.000

If these samples had been taken from a greater depth, the amount of lime would have been still greater, and deeper still would have been made up wholly of that material. From this

it is seen that in this section the soils closely resemble, or are almost identical, with the famous chalk soils of France. No lands on the globe, except the loess, are comparable in fertility to such soils.

These chalk soils are found in more or less abundance in Knox, Holt, Elkhorn, Antelope, and in a few places in Cedar county. Closely allied to them are soils produced by the decomposition of the semi-chalk found along the Republican river in Jefferson, Thayer, Nuckolls, Webster, and Harlan counties. In these counties, however, these chalk soils are so intermingled with or overlaid by the loess, that they escape detection from almost every one except the practiced geologist. But the decomposition of chalk rock was undoubtedly one of the main sources from which the loess itself obtained its large supply of calcareous matter.

THE FORT PIERRE GROUP SOILS

occupy still more limited areas. I have observed them only in patches in Holt and Knox counties, and to a still more limited extent in Dundy and Hitchcock counties. This group of the cretaceous system is characterized in this section by the prevalence of thin beds of sandstone or plastic clays, the former often overlaying the latter. The clays frequently are shaly in structure. The decomposition of these rocks sometimes gives an excess of silicious, and at other places of clayey matter to the soil. When the latter is the case, the soil often has a slaty color which shades into black. The following two analyses illustrates its character, the first being from the upper Republican and the second from Knox county:

	NO. 1.	NO. 2.
Insoluble (silicious) matter	72.876	62.201
Ferric oxide	3.209	4.780
Alumina (clay)	5.897	15.211
Lime carbonate	8.001	8.014
Lime sulphate	2.482	2.873
Lime phosphate	1.608	1.111
Magnesia carbonate	1.888	1.908

	NO 1.	NO. 2.
Potash	.322	.401
Soda carbonates	.671	.733
Sodium sulphate	.485	.211
Organic matter	1.378	.999
Loss in analysis	1.383	.558
Total	100.000	100.000

It will be observed that the above soils contain a large per cent. of clayey matter, along with an abundance of the alkaline earths. They contain also, therefore, the fertilizing elements in a large degree. In seasons of excessive rainfall they would be called sticky, but as a general rule they contain sufficient silicious matter to make them susceptible of the easiest and highest cultivation.

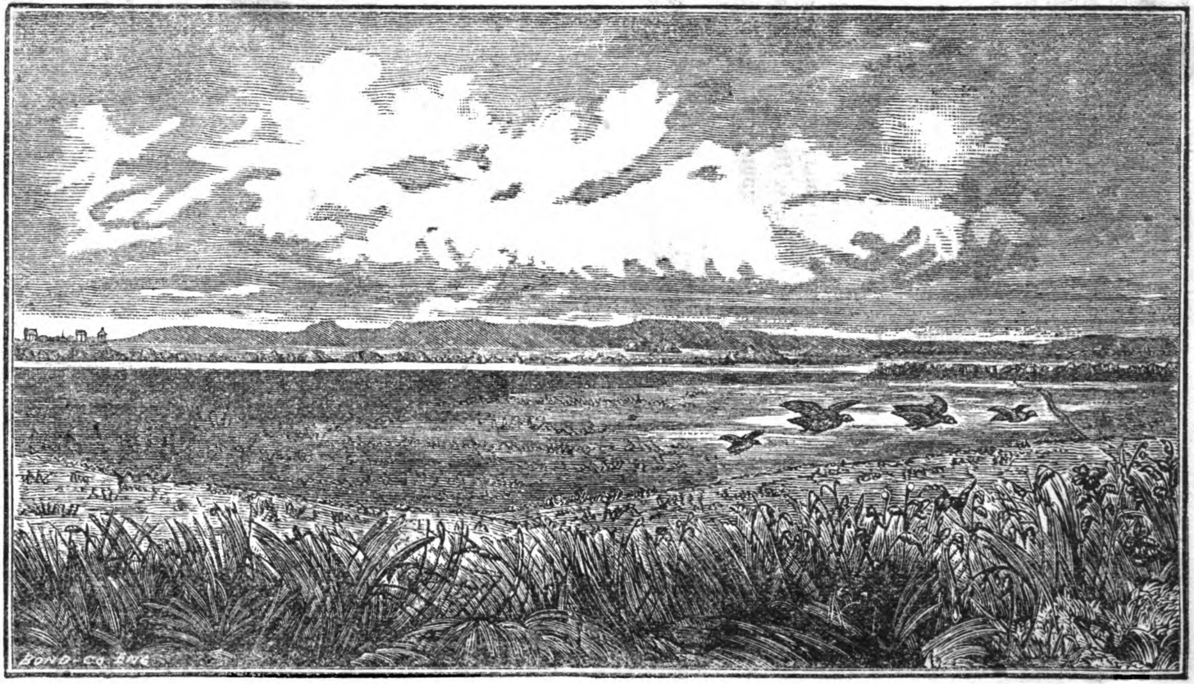
Sandy Soils of the Niobrara and Loup Drainage System.

These are exceedingly varied, but resolve themselves into two general classes, which frequently, however, shade into each other, and also into the kinds already discussed. Though not comparable in extent with the loess and alluvium, they occupy so much territory in northwestern Nebraska that they need to be understood in order to comprehend fully the vast agricultural resources of the State.

Level or Rolling Sandy Lands.

These are found as a general thing south of the main ridge of the Niobrara. This can be understood when it is remembered that the Niobrara flows over a large section of its course along the axis of an anticlinal ridge. On the level or comparatively level tract south of the river where small lakelets abound, the soil is of an exceedingly varied silicious character. Great changes in the surface conditions have evidently here long been going on. The following sections indicate this:

Sand	1 inch	Black Soil	7 inches
Black soil	6 inches	Sand	5 inches
Sand	2 inches	Gravel	unknown depth



PLATTE RIVER, POLK COUNTY, NEBRASKA, SOUTH OF SILVER CREEK.

Ten miles farther west the following section was taken:

Sand	2½ inches	Sand	4 inches
Black soil	4 inches	Black soil	6 inches
Sand	½ inch	Sand	1 inch
Black soil	3 inches	Gravel—bottom unknown,	8 inches
Sand	2 inches		—
Black soil	1 inch	Total	32 inches

Occasionally the upper layer of sand is six or even more inches thick, but generally less. When traveling over this region the soil was examined every few miles, and generally such alternations of character were observed. Only at long intervals did the soil appear to be wholly composed of silicious materials. The sand itself was exceedingly varied, but in general was exceedingly fine, and contained organic matter, and invariably more or less of the alkaline earths. Many partial analyses have been made, and these invariably proved the presence of mineral fertilizers. It can easily be seen that the plow would soon make such soils, near the surface, comparatively homogeneous, and render them highly productive. Nature herself here spontaneously produces the richest grasses. They are represented by a great number of species. In many places, on the flats and around the lakes and lakelets, the grass grows with marvelous luxuriance. Other vegetable forms also abounds, conspicuous among which were an innumerable number of wild flowers. It is true that occasionally a slope made its appearance where vegetation was scant, but such places were more than compensated by the general affluence of floral life. In some sections the soil, even at the surface, is largely made up of black earth, abounding in humus; but these we will not discuss as we are here concerned with the more purely silicious surface deposits.

The extent of this silicious soil has not been ascertained. But it is found in the region, from township No. 22, west to the 103d meridian, and commencing from ten to thirty miles south of the Niobrara, with a breadth varying from ten to thirty miles. A

portion of this section is also occupied by sandhills, but in the main it is either a level or gently rolling region. Its greatest modification is in ranges 27, 28, 29 and 30, where great numbers of lakelets, swamps and sloughs, as already referred to, give an exceptional amount, for this section of evaporating surface, which with the high temperature produced by the silicious soil, helps greatly to generate an abundance of showers throughout the hotter portions of the year. In the same latitude lakelets are found as far west as range 45, but not in the same numbers. Some of these are alkaline, but are easily distinguished from the fresh water lakes by the paucity of vegetation, which is often entirely absent around their borders.

Bounding this silicious region on the south, and often extending far into it, is another, where the soil is a mixture of loess and sand, with occasional spots where the former is found in its purity. The excellence and value of this soil can be understood by the discussions already given.

Sand Hill Soils.

For extent and location of sand hills see my "Geology of Nebraska," pages 297, 298 and 299. The main body of the sand hills have ever been associated with the Niobrara and its tributaries. A marvelous change has come over them since they were first described by Hayden. Then, they were barren and often with not a vestige of vegation. Long afterwards when I visited them, they no longer resembled Hayden's descriptions. Some of them had become grass-covered, and the most barren had a few vegetable forms struggling for existence. The change since then is even greater than that which has occurred between Hayden's visit and my own. Now the most of them have become grass or weed-covered, or clothed with a garment made up of both. During the last summer a gentleman (D. L. Minton, Esq.) brought me a collection of plants gathered from a single sandhill, covering about an acre of ground. In this collection I recognized twenty-one species—seven of which were grasses. These sand-

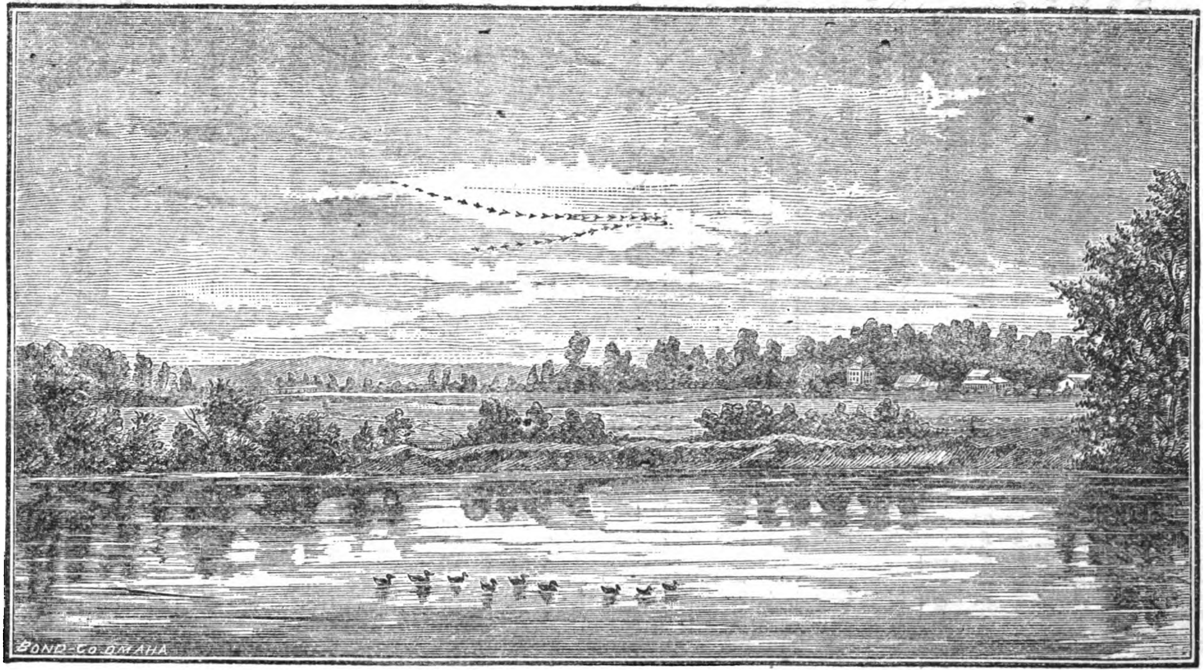
hills, therefore, must have capacity of production in a high degree. To ascertain what these might be, many analyses have been made. One sample brought to me by Mr. Minton, from the hill above referred to, had the following constitution:

Insoluble (silicious) matter	82.110
Ferric acid	2 879
Alumina (clay)	2.281
Lime carbonate	4.473
Lime phosphate	1.390
Lime sulphate	.211
Magnesia carbonate	1.317
Potash	1.004
Soda carbonate	2.982
Organic matter	.373
Moisture	1.121
Total	100.141
Mistake in analysis	.141

The silicious matter in the above was somewhat irregular in character. Fifty per cent. of it was as fine as typical loess. The balance was coarser, and the grains could be recognized with the naked eye, and in this particular differing greatly from the loess soils. It will be observed, however, that the soil contained a relatively large quantity of clay, and an abundance of these alkaline earths that are recognized as the best fertilizers. It is evident that all the sand hills need, is sufficiency of moisture to produce the crops that are common to temperate latitudes.

Two additional analyses were made from sandhills a little west of longitude 102°, and south of Snake river—a tributary of the Niobrara. The hills rise seventy-five feet above the general level, and the samples were taken two-thirds of the distance from the bottom or lower edges:

Insoluble (silicious) matter	85.143	84.120
Ferric acid	2.741	3.772
Alumina	1.284	1.001
Lime carbonate	3.689	4.718
Lime phosphate	1.384	1.200



LOUP RIVER, NEAR COLUMBUS, NEBRASKA.

Lime sulphate	.781	.411
Magnesia carbonate	.978	1.492
Potash	.997	1.004
Soda carbonate	1.027	1.587
Organic matter	.940	.729
Loss in analysis	.836	.991
Total	100.000	100.000

In both these samples a portion of the sand was exceedingly fine, and a portion comparatively coarse. As in the former case, the amount of alumina present, and the alkaline earths is capable, with sufficiency of moisture, to render these sands highly productive, and the fact that all over the sand-hill region the land is becoming clothed with vegetation, is evidence, both of increasing rainfall, and the presence in a large degree of natural fertilizers. This becomes the more apparent when we compare the analysis or New Jersey sand with another analysis from the sand hills of Nebraska, taken from fifteen miles south of Snake river:

	NEB.	N. J.
Insoluble (silicious) matter	86.008	93.08
Ferric acid	2.399	1.22
Alumina	1.129	.70
Lime carbonate	3.999	1.88
Lime phosphate	1.334	.47
Lime sulphate	.580	......
Magnesia carbonate	1.007	.75
Potash	1.001	.49
Soda carbonate	1.248	.33
Organic matter	.801	.50
Loss	.594	.56
Total	100.000	100.00

The above specimen of New Jersey sand was taken from a section in the southeastern part of the State, where the land even in that moist section was almost wholly devoid of vegetation. The above analysis shows by comparison with a Nebraska specimen from one of the sand hills, that it is incomparably inferior in the elements of fertility to the latter. But these New Jersey sands

are made fertile by giving them a thin covering of marl. This is sufficient to start clover where roots permeate the soil and leave there sufficient organic matter to start into life other crops. By such a system of tillage, New Jersey has become the vegetable and fruit garden of the East. What is done there could be done if needed, on a still grander scale in this sandy region of Nebraska. The underlying rocks there are mostly of Pliocene-Tertiary age, and the characteristic deposits are marl beds. These beds of marl are exposed in hundreds of places in Northwestern Nebraska, and where not exposed, can generally be reached readily by digging. Many of the green marl beds on the Loup are from five to thirteen feet thick. On the Niobrara I have seen them seventeen feet thick, with gray marls above and beneath them. They are exposed on many of the upper tributaries of the Niobrara, especially on and along Long Pine creek, Rapid creek, Snake river, Fawn creek, Big medicine, etc. On the Upper Republican, and its tributaries, marl beds occur from twenty to forty feet thick, and can be traced without difficulty for hundreds of miles. It is apparent, therefore, that whenever these lands, whether only silicious or regular sand hills, are needed or wanted for agricultural purposes, their natural fertility will render them profitable, and, should any of them be found to lack the necessary ingredients for farming purposes, or be soon exhausted, nature has close at hand an inexhaustible store of the finest fertilizing material, which is both accessible and the cheapest possible.

What is here stated in reference to the Niobrara and its tributaries, applies more or less closely to the country as far towards the northwest as the White Earth river. It is evident, therefore, that a marvelously small amount of Northwestern Nebraska is an agricultural waste.

The Canyon Region.

This section, which commences ninety miles west of the mouth of the Niobrara, owes its origin and character partly to the synclinal, along whose axis the river flows. Lateral streams in

endless number flow into the main river, and these have cut down their bed to the same level. As the canyon is from 300 to 400 feet deep, the mazy labyrinths here are very difficult to explore. Vegetation, however, is exceedingly affluent, as all the peculiar grasses, flowers, shrubs and trees of Northern Nebraska luxuriate here. It was a paradise for wild animal life, and is now one for herds. Even here, however, are many level spots of upland where a farm can be made. The soil yielding the productions of wild nature so freely must of course be adapted to the needs of civilization. And the true policy to be pursued even here is, to let the men who can find homesteads, cultivate and possess the land in peace. It must become the policy of the government to continue in operation that system of land laws, which furnishes homes for the greatest number of people. Possible agricultural lands must not be given up to an exclusively pastoral use; but rather must the semi-barbarian system of preserving vast tracts for the exclusive use of a few cattle kings be surrendered for the good of the more numerous classes, who desire or crave small tracts for homes. Such a policy, if continued, will eventually fill even Northwestern Nebraska with a happy and contented agricultural population.

The Bow Rivers

are in northeastern Nebraska. They are known as the East, the Middle, and West Bow. The water is clear and cold. They originate in the coolest and most delightful springs of water. In the centre of Cedar county, near Curlew, there is a spring of cold water that emerges from a bluff, strong enough to turn a mill. In fact, almost every half mile, along these rivers, these magnificent springs make their appearance. Except the East Bow, their general direction is northeast. The East Bow flows northwest until it unites with the Middle Bow. Below St. James, all united, they join their waters to those of the Missouri. Sooner or later, when fish culture receives the attention in this State which it deserves, these Bow rivers will become noted as trout streams.

VIEW OF THE NORTH LOUP VALLEY, NEAR SCOTIA AND LAMARTINE, GREELEY COUNTY.

The Nemahas

early became noted rivers in Nebraska. The north branch of the Nemaha runs in a southeasterly direction, diagonally through Johnson and Richardson counties, until it unites with the main river, in the latter county. Its length is about sixty miles, and increases regularly in size from its source to its mouth, by the addition of numerous tributaries. The main Nemaha rises in Pawnee county, takes a southerly direction into Kansas, then turns northeast into Richardson county, and then flows a little south of east, until it unites with the Missouri near the southeast corner of the State. Its length is but sixty miles, but it receives so many comparatively large tributaries, that its magnitude at the end of its course is much greater than many much longer rivers. The bottom lands of these rivers are broad, often beautifully terraced, and the bordering bluffs are gently rounded off. The impression left on the mind, after traversing these valleys, is that their beauty cannot be surpassed. The fall and size of these rivers and their larger tributaries, will supply motive power to an immense number of manufacturing industries. The Little Nemaha is a smaller edition of the "Big Nemaha." It rises in Cass county, flows in a southeasterly direction through Otoe and Nemaha counties, and unites with the Missouri near Nemaha city, in Nemaha county. It also has numerous tributaries. It is a beautiful stream of water, and with its characteristic wide bottoms and gently rounded bluffs, gives character to the counties through which it flows.

The Blues

are among the most important rivers of Nebraska. The Big Blue with its tributaries drains eight counties, which are among the best in the State. It is about 132 miles long. It rises in Hamilton county, and after flowing for thirty six miles, a little northeast, it curves around and follows a southeast direction through Butler, Seward, Saline and Gage counties. It enters Kansas from the Otoe Reservation, where it ultimately unites

with the Republican. The Middle Fork of the Blue also rises in Hamilton county, and flowing first a little north of east, unites with the North Blue at Seward. Its length is about sixty miles. The West Fork of the Big Blue rises in Hall county, and flows a little north of east through Hamilton, then east through York, and then southeast through Seward, and finally unites with the main Blue, five miles above Crete, in Saline county. School creek and Beaver creek are tributaries of the West Fork of nearly the size of the parent stream. Turkey creek is also a large tributary from the northwest, which unites with the Blue near the line of junction between Saline and Gage counties. All these Blue rivers and their tributaries, few of which can even be alluded to, are remarkable for the amount of water which they carry, and the great beauty of the bottom lands through which they meander. The uplands between the bottoms are also for the most part gently rolling, and composed of the richest soil. The bottoms are often terraced, and the materials in such cases are mostly of a loess character. The bluffs bordering these bottom lands are generally gently rounded off, and infinitely varied. It is doubtful whether the mind could imagine a section better supplied with rivers and creeks and rivulets, giving an abundance of water privileges of the best character. There is such an abundance of water in these rivers and their tributaries, and the fall adequate, that the motive power is ready to propel a vast amount of machinery for manufacturing industries. With superior water privileges and the choicest lands, a dense population must here rapidly accumulate.

The Little Blue rises in Adams county, and flows in a southwesterly direction through Clay, Nuckolls, Thayer, and in the southeast corner of Jefferson county enters Kansas, where it finally unites with the Big Blue. About 110 miles of this river are in Nebraska. In its most important features it resembles the Big Blue. It also has numerous tributaries, which are in miniature what the parent stream is.

Salt Creek

derives its name from the number of saline springs and bogs that unite with it in Lancaster county. It is formed near Lincoln by the junction of Oak creek, Middle creek, South creek, and other small streams. From this place it flows in a northeasterly direction until it unites with the Platte below Ashland. It is a rather deep stream with a muddy bottom. Its valley is composed of remarkably fine bottom lands. The slope from the bottom up to the top of the bluff on the southeast side, is exceptionally gentle. In many places it is impossible to tell where the bottom leaves off and the upland begins.

"Chief of all, not only of Nebraska, but of the United States, is the Missouri, because it gives character to all the rivers that unite with it below down to the Gulf. Forming the eastern border of the State, and a small extent of its northern boundary, and being tortuous in its path, at least 500 miles of the river are on the northern and eastern side of Nebraska. It is deep and rapid. Its bed is moving sand, mud and alluvium. It no where in Nebraska has rock bottom. Before rock can be reached a thickness of from forty to one hundred feet of sand and mud must be penetrated from low water mark. Its immediate banks, sometimes on both, and almost always on one side, are steep—often, indeed, perpendicular or leaning over toward the water. It is generally retreating or advancing from, or to the other shore. It is the shore from which it is retreating that is sometimes gently sloping, while the one towards which it is advancing is steep. This steepness is produced by the undermining of the banks, and the caving that follows. Near the bottom there is a stratum of sand, which being struck by the current is washed out and the bank falls in. Many acres in some places have been carried away in a single season. The principal part of this "cutting" is done while the river is falling. The water is always muddy or full of finely comminuted sand; the current rapid and full of whirling eddies. Often, during flood does the boiling, seething mass of water look as if it had been stirred up at the bottom

with the sand by some mighty convulsion of the earth. Few that fall into it ever reach the shore alive without assistance. The clothes are soon saturated with the sediment of the river which is always turbid or muddy, and sinks the victim to the bottom. So well understood, however, is this feature of the Missouri that no more persons are drowned in it than in other rivers of corresponding magnitude. A position on some of the terraces or bluffs overlooking the river gives views of unsurpassed beauty. With some obnoxious elements attached to its character, it is as we have already seen, a storehouse of blessings to the sections through which it flows. Had it not been for the Missouri the settlement of this region would have been indefinitely delayed. It is a highway to the commerce and markets of the world; and on this highway the first emigrants reached Nebraska, and sent off their products to other regions. As the Missouri is navigable for 2,000 miles above Omaha, it was a great highway for traffic with the mountain regions of Idaho, Dakota and Montana. Since the building of railroads its business has fallen off. Vessels still run from Sioux City and Yankton to the Upper Missouri and the Yellowstone. Latterly there are indications of a revival of business on the Lower Missouri."

It is clearly evident from the rapid settlement and agricultural development of the Northwestern States and Territories, drained by the Missouri river and its navigable tributaries, that its capacity for transportation will in a few years, in answer to public demand, be greatly improved.

The recent minute examination of the Missouri river, from St. Louis to Yankton, proves that all difficulties or obstructions to cheap and easy tranportation, may be overcome by skillful engineering.

The Nebraska segment, or portion of the Missouri river, extends from the mouth of the Nemaha to Niobrara, a distance by water of nearly 500 miles.

That portion or region of Nebraska immediately affected by the Missouri river, consists, 1st—the bottom lands; 2nd—the

bluff region adjacent to the river. The bottom lands comprise a belt nearly ten miles in width, and are mostly on the east side of the river. The law determines the State line between Iowa and Nebraska in the middle of the stream, but as no one can locate the line aforesaid for a period longer than twenty-four hours, the eastern boundary of Nebraska will always be indefinite. In the general course of both the Missouri and Mississippi rivers the wide expansive bottoms are on the east side of the stream, leaving abrupt bluffs on the Nebraska side. It would be most interesting to know the probable cause. It is doubtless connected with the earth's rapid motion upon its axis from west to east, throwing such extensive streams on the west side of their courses.

In this connection, one can hardly pass by without notice the perennial conundrum of the rural school-master, or rather of the school district, viz: "Why do the waters of the Missouri river run up hill?" An inference, doubtless, from its mouth—the Gulf of Mexico—being nearer the earth's equatorial diameter; and its rise far north, over 4,000 miles towards the earth's Polar diameter. We are inclined to help the school-master by having him take the water level of any 100 miles of the river in five or ten mile sections, and note the actual facts; he will invariably report that each five mile section in the direction of the flowing current, is actually lower than the preceding one by a certain number of feet, thus practically settling the question.

A List of The Streams in Nebraska.

NORTH OF PLATTE RIVER.	MILES	SOUTH OF PLATTE RIVER.	MILES
Main Platte river	350	Republican river	350
North Platte river	200	Stillwater creek	20
South Platte river	90	Willow creek	20
Niobrara river	400	Crooked creek	30
White river	60	Indian creek	30
Lodge Pole creek	100	Turkey creek	30
Lawrence Fork	70	East and West Muddy	60
	50	Medicine creek	90

A List of the Streams.—*Continued.*

NORTH OF PLATTE RIVER.

	MILES
Snake river	80
Boardman's creek	40
Long Pine creek and branches	80
Elkhorn river	390
Bell creek	45
Maple creek	80
Logan creek branches	140
Plum creek	40
Union creek	30
Papillion	60
Shell creek	90
Loup river with North Fork	290
South Fork Loup river	170
Middle Loup	230
Dismal	70
Calamus	80
Beaver creek	20
Council creek	50
Cedar creek	120
Timber creek	15
Spring creek	30
Prairie creek	120
Wood river	150
Total north of the Platte	3840
Total south of the Platte	2798
Total length of streams	6648

SOUTH OF PLATTE RIVER.

	MILES
Red Willow creek	80
Frenchman's Fork	90
Driftwood creek	158
Beaver creek	140
Sappa creek	140
Prairie Dog creek	150
Little Blue	160
Cottonwood creek	30
Pawnee creek	30
Big Sandy	65
South branch Big Sandy	30
Muddy Creek	35
Big Blue	170
West Blue	100
Beaver creek	60
Lincoln creek	65
Turkey creek	70
Swan creek	30
Cole creek	20
Indian creek	35
Big Nemaha river	125
South Fork Nemaha	80
Muddy creek	80
Long Branch	25
Little Nemaha	90
North Branch	40
South Branch	40
Muddy creek	25
Spring creek	20
Weeping Water	35
Salt creek	60
Wahoo	40
Total South Platte	2798

LIST OF FRESH WATER LAKES IN NEBRASKA.

TOWN.	RANGE.	NUMBER.	ACRES.
25	10 East	1	300
20	7 "	1	30
23	8 "	1	30
6	14 "	1	20
17-18.	12 "	1	127
16	13 "	1	74
26	5 West	1	15
25	15 "	1	130
27	16 "	1	5
28	16 "	1	55
27		5	175
28	17 "	4	430
29		2	130
17	22 "	3	15
17	23 "	1	3
31	25 "	1	10
29		3	645
30	27 "	3	970
32		2	275
27		4	175
28		6	290
29	28 "	4	865
30		5	1150
31		4	1020
29	29 "	4	800
30		4	530
27	31 "	1	30
21	34 "	2	80
26	35 "	1	5
27		1	5
24	36 "	1	40
20	37 "	8	98
25	37 "	1	80
34	37 "	1	25
20	44 "	1	700
31	45 "	1	15
20	45 "	1	460
		87	9807
There are 12 more lakes unsurveyed which at same average would give		12	1353
		99	11160

To have in mind the more prominent physical features of Nebraska, one should make a special study of its bolder outlines

and altitudes, such as can be comprehended in grouping and comparing its various well defined river and valley systems. After a few studious efforts in this direction, based upon accurate measurements, the observer receives such clear and proper impressions as to render him both intelligent and entertaining upon the leading questions of climate and production.

Following this suggestion, let us make the attempt to group the physical outlines and reliefs of Nebraska. First, the Missouri river, with its broad curves, sweeps around from the northwest (occupying with its flood plains the lowest level, from 800 to 2,000 feet above the sea), throughout an extent of nearly 10,000 square miles. Its broad scope of low level or bottom lands, from six to twelve miles in width for many hundred miles, are flanked with magnificent bluffs of loess formation, eroded or sculptured into bold forms, which meet the eye on either side, like minature mountain ranges, wholly relieving the scenery from solitary and monotonous effects. Nearly at right angles with it, bearing nearly due east along a rapidly descending incline of uniform grade, ten feet per mile, comes the broad Platte, whose bright waters flashing in the sun, press forward in all directions, over ripples, shallows and sandbars that form rapidly and invisibly; standing firm for an hour or a day, then at once disappearing to form again below, as if the restless waters were impatient to escape to the great river en route to the distant sea, and the filmy barriers of tawny sands were on the alert to prevent their escape. The entire course of the Platte presents a scene of varied activity and life, which compels the tourist, with new facts and theories, to return with new sensations of curiosity and pleasure, and notice the peculiar ways of these restless waters.

Let us now add to this picture the simple scenery of the Elkhorn, with its winding course of 250 miles in length, falling six feet per mile. It thus presents, inclining towards the sun, a magnificent valley scooped out of the fertile loess, and already occupied from its source to its mouth with productive farms. The river and

valley of the Logan reach the Elkhorn thirty-five miles above the mouth of the latter. The course of this charming stream is nearly north, occupied on both sides with beautiful and now valuable farms, just subdued by the plow from the recent wilderness of rolling prairie. Its length, with branches, is 140 miles, with an average descent of six feet per mile, so that the lower Logan valley is several hundred feet lower than its upper portion. Again, nearly 500 feet higher in altitude than the Missouri at Omaha, the North, Middle and South Loups concentrate their waters at Columbus. They are the contributors or drainage of a vast circular basin or amphitheater of 20,000 square miles. The Loup basin has its general inclination also towards the south, with an average descent of eight feet per mile; so that while its upper course is 2,500 feet above sea level, its out lower side or outlet is only 500 feet above the sea. It is thus protected from the fierce north winds of Dakota by the distant Niobrara divide.

Like the Loups north of the Platte, the Blues form the principal drainage basin in central Nebraska south of the Platte. It is also, like that of the Loup, an elevated valley or basin, being in Saline county 450 feet above the Missouri river at Omaha, and 200 feet above the valley of Salt creek, which at Lincoln, twenty miles distant, flows in the opposite direction.

CHAPTER XII.

Statistical Review of Nebraska by Counties, with Notes of Comparative Progress, Compiled from Official Returns.

ADAMS COUNTY.

ORGANIZED in 1867. Number of square miles, 576; acreage, 368,640; 1,850 feet above sea level. Crops in 1880: 57,809 acres of wheat; 31,276 acres of corn; number of fruit trees for the year 1879: peach, 18,364; apple, 17,627; plum, 9,839; cherry, 1,814; pear, 529; grape vines, 3,574. For 1880—fruit trees, 82,693; forest trees, 923,456.

Tax valuation—

In 1881 (estimated)...	$2,234,579.00	In 1877 (actual)......	$ 923,594.90
In 1880 (actual)......	1,943,060.33	In 1876 "	1,048,913.60
In 1879 "	1,734,848.17	In 1875 "	1,117,328.50
In 1878 "	1,289,657.45		

Population from 1874 to 1880—

1874	2,694	1878	5,583
1875	3,093	1879	8,162
1876	3,940	1880	10,239

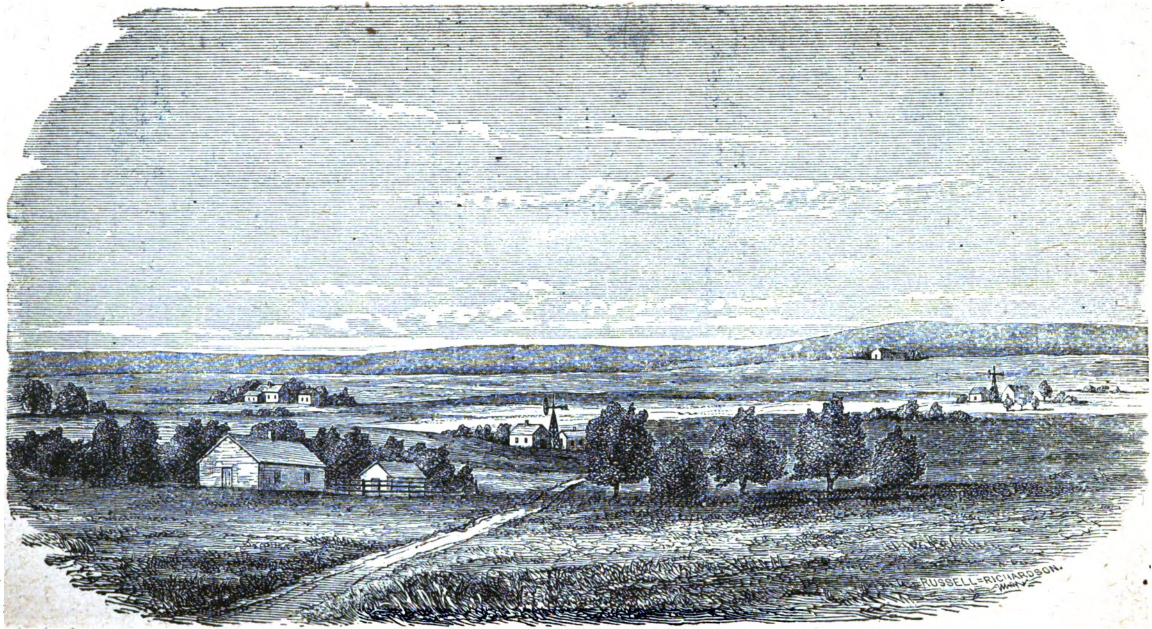
Schools in 1880: number of districts, 66; children of school age, 3,275; number of qualified teachers employed—males 52, females, 41; value of school houses, $31,492.

ANTELOPE COUNTY.

Organized in 1871. Number of square miles, 864; acreage, 552,960. Crops in 1880: 4,300 acres of wheat; 5,671 acres of corn. Number of fruit trees for 1880, 3,492; forest trees, 201,443.

Population from 1874 to 1880—

1874	1,387	1878	1,575
1875	1,289	1879	2,178
1876	1,363	1880	3,959



VIEW IN ADAMS CO., SOUTH OF HASTINGS, NEB.

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Center	599	....	Mills }	282	830
Twin Grove	467	.....	Sherman }	117	
Elm Grove and Center	341	1,756	Population of Co.	2,178	3,959
Cedar and Twin Grove	372	1,373			

Tax valuation—

In 1881 (estimated)	$591,252.00	In 1877 (actual)	$335,850.00
In 1880 (actual)	514,132.50	In 1876 "	302,697.00
In 1879 "	319,119.00	In 1875 "	338,727.00
In 1878 "	330,753.00		

Schools in 1880: number of districts, 42; school houses, 37; children of school age, 1,252; number of qualified teachers employed—males, 7, females, 30; value of school houses, $4,225.

Boone County.

Organized in 1871. Number of square miles, 672; acreage, 430,800. Crops in 1880: 14,294 acres of wheat; 5,367 acres of corn; number of forest trees for the year 1879, 424,360. Number of fruit trees: peach, 521; plum, 478; cherry, 185; pear, 33; number of grapevines, 509. For 1880: fruit trees, 9,077; forest trees, 417,895.

Population from 1874 to 1880—

1874	798	1878	1,503
1875	965	1879	2,626
1876	1,099	1880	4,177

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Manchester and Boone	421	1,199	Ashland }	122	672
Cedar and Dublin	396	864	Oakland }	266	.....
Shell Creek	376	595	Beaver and Plum Creek	381	892
Plum Creek	240	.....	Dublin	117	
Boone	307	.....	Population of Co.	2,626	3,222

Tax valuation—

In 1881 (estimated)	$588,749.00	In 1877 (actual)	$335,642.50
In 1880 (actual)	571,956.00	In 1876 "	370,955.37
In 1879 "	330,054.00	In 1875 "	358,434.00
In 1878 "	313,146.75		

Schools in 1880: number of school districts, 39; children of school age, 1,249; number of qualified teachers employed—males, 10, females, 21; value of school houses, $4,030.

BUTLER COUNTY.

Organized in 1866. Number of square miles, 594; acreage, 351,360; 1,500 feet above sea level. Crops in 1880: wheat, 38,891 acres; corn, 28,688 acres; number of forest trees, 1,400,505; number of fruit trees for the year 1879: apple, 6,454; plum, 1,411; pear, 322. For 1880: fruit trees, 20,416; forest trees, 1,612,502.

Population from 1874 to 1880—

1874	4,027	1878	6,025
1875	4,440	1879	7,310
1876	4,730	1880	9,193

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Linwood	1,008	1,075	Oak Creek	397	526
Bone Creek	515	603	Center	456	522
Savannah	339	347	Union	386	513
Alexis	410	570	Reading	622	780
Summit	343	436	Read	305	381
Olive	410	497	Ulysses	304	725
Franklin	1,082	1,518	Spurk	36	.....
Skull Creek	621	657	Richardson	75	143

Tax valuation—

In 1881 (estimated)	$2,440,441.00	In 1877 (actual)	$1,188,289.00
In 1880 (actual)	2,123,123.00	In 1876 "	1,192,644.00
In 1879 "	1,726,163.00	In 1875 "	1,318,777.00
In 1878 "	1,629,678.00		

Schools in 1880: number of districts, 69; children of school age, 3,041; qualified teachers employed—males, 61, females, 45; value of school houses, $29,551.85.

BURT COUNTY.

Organized in 1855. Number of squre miles, 441; acreage, 282,240. Crops in 1880: wheat, 14,108 acres; corn, 28,038 acres; number of fruit trees for the year 1879: apple, 61,617; plum, 9,559; cherry, 2,919; peach, 1,638; pear, 643. For 1880: fruit trees, 43,764; forest trees, 1,708,330.

Population from 1874 to 1880—

1874	3,866	1873	4,992
1875	4,041	1879	5,165
1876	4,354	1880	6,949

Population by precincts—

PRECINCTS	1879.	1880.	PRECINCTS	1879.	1880.
Arizona	618	627	Everett	576	915
Decatur	804	1,035	Riverside	260	....
Oakland	954	1,457	Tekamah	1,033	1,458
Silver Creek	409	....	Silver Creek / Riverside	....	810
Bell Creek	50	674			

Tax valuation—

In 1881 (estimated)	$2,093,686.00	In 1877 (actual)	1,250,017.00
In 1881 (actual)	1,820,597.00	In 1876 "	1,273,981.00
In 1879 "	1,406,160.00	In 1875 "	1,324,646.25
In 1878 "	1,449,724.00		

Schools in 1880: number of districts, 69; children of school age, 1,316; number of qualified teachers employed—males, 35; females, 65; value of school houses, $30,960.

BUFFALO COUNTY.

Organized in 1855. Number of square miles, 900; acreage, 576,000. Crops in 1880: wheat, 2,265 acres; corn, 1,270 acres; number of forest trees, 225,000. For the year 1879: number of fruit trees—apple, 2,199; plum, 506; peach, 470; pear, 33; cherry, 32. For 1880: fruit trees, 41; forest trees, 14,100.

Population from 1874 to 1880—

1874	2,106	1878	4,819
1875	2,861	1879	6,878
1876	4,396	1880	7,535

Population by precincts—

PRECINCTS.	1879.	1880.
Shelton	830	917
Gibbon	794	746
Center	1,048	946
Kearney	1,920	2,123
Odessa } Western	182	.....
	300	.....
Buffalo }	135	} 603
Grant }	.....	
Taylor }	313	

PRECINCTS.	1879.	1880.
Divide }	886	} 603
	.....	
Loup }	285	
Cedar }	163	} 932
Schneider }	426	
	.....	
Gardner } Beaver }	172	
Population of Co.	.....	7,535

Tax valuation—

In 1881 (estimated)	$1,774,442.00	In 1877 (actual)	$1,102,810.05
In 1880 (actual)	1,542,993.98	In 1876 "	1,412,458.77
In 1879 "	1,217,106.74	In 1875 "	1,105,232.00
In 1878 "	1,202,294.46		

Schools in 1880: number of districts, 56, children of school age, 2,324; number of qualified teachers—males, 33; females, 49; value of school houses, $19,720.

Cass County.

Organized in 1855. Number of square miles, 550; acreage, 352,000; 1,000 feet above sea level. Crops in 1880: wheat, 32,831 acres; corn, 72,518 acres; number of forest trees, 899,730. For the year 1879, with 303½ miles of hedge; number of fruit trees—apple, 105,687; peach, 49,373; cherry, 13,578; plum, 3,572; pear, 1,279; grapevines, 6,221. For 1880: fruit trees, 147,680; forest trees, 2,717,516.

Population from 1874 to 1880—

1874	10,397	1878	11,936
1875	10,452	1879	13,435
1876	10,787	1880	16,688

PRAIRIE VIEW, CASS COUNTY, NEBRASKA.

Population by precincts—

PRECINCTS.	1879.	1880.
Plattsmouth City	2,629	4,306
Rock Bluffs	1,251	1,212
Liberty	1,215	1,251
Plattsmouth	975	1,201
Greenwood	729	883
Stone Creek	721	779
Weeping Water	683	818
Eight Mile Grove	664	851
Elmwood	629	765
Center	594	702
Tipton	575	720
South Bend	573	1,488 (South Bend and Louisville)
Louisville	544	
Salt Creek	558	652
Avoca	558	575
Mount Pleasant	474	564

Tax valuation—

In 1881	(estimated)	$3,943,302.00
In 1880	(actual)	3,428,959.01
In 1879	"	3,058,135.73
In 1878	"	3,287,283.00
In 1877	(actual)	$3,235,168.30
In 1876	"	2,891,242 60
In 1875	"	3,593,017.00

Schools in 1880: number of districts, 86; school houses, 86; number of children of school age, 5,507; number of teachers employed—males, 71, females, 92; total value of school property, $73,030.

Clay County.

Organized in 1867. Number of square miles, 576; acreage, 368,640; 1,775 feet above sea level. Crops in 1880: wheat, 76,062 acres; corn, 33,171 acres. Number of forest trees, 3,114,-828. For the year 1879, with 46 miles of hedge: number of fruit trees—apple, 14,249; plum, 10,640; cherry, 3,074; pear, 652; number of grape vines, 2,643. For 1880: fruit trees, 83,-615; forest trees, 3,374,193.

Population from 1874 to 1880—

1874	3,622
1875	4 183
1876	4,787
1878	7,012
1879	9,373
1880	11,299

Population by precincts—

PRECINCTS.	1879.	1980.	PRECINCTS.	1879.	1880.
Logan	339	442	Sutton	1,391	1,631
Edgar	830	1,080	Lewis	411	503
Fairfield	722	918	Lynn	474	602
Spring Ranche	419	447	Scott	447	500
Glenville	428	504	Leicester	440	505
Lone Tree	348	542	Harvard	1,176	1,384
Marshall	379	409	Lincoln	516	621
Sheridan	330	405	School Creek	723	802

Tax valuation—

In 1881 (estimated)	$2,321,233.00	In 1877 (actual)	$1,322,204.85
In 1880 (actual)	2,018,463 88	In 1876 "	1,341,252.27
In 1879 "	1,700,704.10	In 1875 "	1,311,074.00
In 1878 "	1,540,715.00		

Schools in 1880: number of districts, 68; school houses, 71; children of school age, 3,632; number of qualified teachers employed—males, 45, females, 54; value of school houses, $42,629.

Cedar County.

Organized in 1859. Number of square miles, 792. Crops in 1880: wheat, 8,563 acres; corn, 7,994 acres. Number of forest trees, 857,437, with 5⅜ miles of hedge; number of fruit trees—apple, 1,310; peach, 159; plum, 130; cherry, 61; pear, 26; three acres of grape vines.

Population from 1874 to 1880—

1874	1,817	1878	2,400
1875	1,979	1879	2,775
1876	2,421	1880	2,898

Tax valuation—

In 1881 (estimated)	$1,104,565.00	In 1877 (actual)	$ 813,905.00
In 1880 (actual)	960,492.00	In 1876 "	886,785.00
In 1879 "	912,467.00	In 1875 "	1,015,495.00
In 1878 "	965,534.00		

Schools in 1880: number of districts, 30; school houses, 30; children of school age, 1,132; whole number of children that

attended school during the year, 727; number of qualified teachers employed—males, 19, females, 19; value of school houses, $94,677.

Cheyenne County.

Organized 1867. Number of square miles, 7,224; acreage, 4,623,360.

Population from 1873 to 1880—

1874	449	1878	889
1875	457	1879	1,218
1876	476	1880	1,560

Population by precincts:

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Sidney	935	1,279	Big Springs	22	281
Porter	52		Lodge Pole	79	
Antelope	52		Court House	87	
Total population of County				1,218	1,560

Tax valuation—

In 1881 (estimated)	$2,284,517.00	In 1877 (actual)	1,639,922.00
In 1880 (actual)	1,986,536.00	In 1876 "	1,402,741.00
In 1879 "	1,670,748.00	In 1875 "	1,380,659.00
In 1878 "	1,669,495.00		

Schools in 1880: number of districts, 4; school houses, 1; children of school age, 265; value of school houses, $3,500.

Colfax County.

Organized in 1869. Number of square miles, 414; acreage, 264,960; 1,335 feet above sea level; number of acres of forest trees, 961; number of fruit trees: apple, 4,683; cherry, 868; peach, 788; plum, 444; pear, 95; number of grape vines, 1,053, with 8 miles of hedge. No returns for crops for 1880.

Population from 1874 to 1880—

1874	3,458	1878	5,080
1875	3,651	1879	5,960
1876	4,187	1880	6,604

Population by precincts:

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Richland }	362	862	Midland	603	651
Shell Creek }	455		Adams	383	...
Wilson }	340	830	Colfax	523	652
Stanton }	213		Maple Creek	5C0	527
Schuyler	1.160	1,383	Lincoln and Adams	512	1,115
Grant	539	584			

Tax valuation—

In 1881 (estimated)	$1,628,638.00	In 1877 (actual)	1,246,129.90
In 1880 (actual)	1,416,208.00	In 1876 "	1,170,795.00
In 1779 "	1,376,724.00	In 1875 "	1,156,335.32
In 1878 "	1,413,533.00		

Schools in 1880: number of districts, 53; children of school age, 2,335; value of school houses, $21,440.

Cuming County.

Organized 1855. Number of square miles, 576; acreage, 368,640. Crops in 1880: wheat, 24,341 acres; corn, 22,983 acres; number of fruit trees, 25,000; forest trees, 720,925.

Population from 1874 to 1880—

1874	3,644	1880	5,577

Population by precincts:

PRECINCTS.	1880.	1879.	PRECINCTS.	1880.	1879.
Cuming	594	499	St. Charles	822	761
West Point	2,160	1,546	Wisner	1,416	1,137
Lincoln and Bismarck	996	965	Logan	810	699

Tax valuation—

In 1881 (estimated)	$2,155,340.00	In 1877 (actual)	1,045.414.86
In 1880 (actual)	1,874,208.75	In 1876 "	1,217,401.30
In 1879 "	987,286.56	In 1875 "	1,246,551.00
In 1878 "	949,291.92		

Schools in 1879: number of districts, 45; children of school age, 2,047; number of qualified teachers—males, 29; females, 20; value of school houses, $23,375.

CUSTER COUNTY.

Organized 1877. Number of square miles, 2,592; acreage, 1,658,880. Crops in 1880: wheat, 354 acres; corn, 392 acres.

Population from 1878 to 1880—

1878	371	1880	2,211
1879	696		

Population by precincts:

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Number Two / " Four	225	508	Nos. 3, 5 and 6	275	837
			Nos. 1, 7, 8 and 9	350	867
Total population of County				840	2,211

Tax valuation—

In 1881 (estimated)	$263,803.00	In 1879 "	180,946.25
In 1880 (actual)	229,394.00	In 1878 "	136,054.50

Schools in 1880: number of districts, 17; school houses, 9; children of school age, 339.

DAKOTA COUNTY.

Organized 1855. Number of square miles, 250; acreage, 160,000. Crops in 1880: wheat, 3,679; corn, 8,927 acres; forest trees, 565,000.

Population from 1874 to 1880—

1874	2,759	1878	3,107
1875	2,759	1879	3,208
1876	3,006	1880	3,216

Population by precincts:

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Omadi	873	916	Covington	262	315
St. Johns	696	1,153	Summit	297	.....
Summit and	...		Dakota	805	832
Pigeon Rock	...		Pigeon Creek	295	.....

Tax valuation—

In 1881 (estimated)	$891,772.00	In 1877 (actual)	840,047.86
In 1880 (actual)	775,454.00	In 1876 "	801,018.00
In 1879 "	720,780.00	In 1875 "	637,665.00
In 1878 "	834,700.00		

Tree Planting, Dakota County, Nebraska.

Schools in 1880: number of districts, 33; school houses, 30; children of school age, 1,304; qualified teachers employed, 51—males, 26; females, 25; value of school houses, $19,375.

DAWSON COUNTY.

Organized in 1859. Number of square miles, 1,008; 2,370 feet above sea level; number of acres, 645,120; number of forest trees, 950. Crops in 1880: wheat, 2,300 acres; corn, 4,000 acres.

Population from 1874 to 1880—

1874	800	1878	2,581
1875	1,407	1879	3,871
1876	2,133	1880	2,910

PRECINCTS.	1880.	1879.	PRECINCTS.	1880.	1879.
Number 1, Wood River	775	642	Number 2	1,275	968
Coyote, Cozad	625	605	Number 3, Platte	710	665
Total population of county				3,385	2,910

Tax valuation—

In 1881 (estimated)	$808,171.00	In 1877 (actual)	$714,103.16
In 1880 (actual)	702,758.00	In 1876 "	813,170.00
In 1879 "	676,805.95	In 1875 "	905,927.46
In 1878 "	698,829.36		

Schools in 1880: number of districts, 28; school houses, 18; children of school age, 784; number of qualified teachers employed—males, 13, females, 11; value of school houses, $15,380.

DIXON COUNTY.

Organized in 1859. Number of square miles, 450; acreage, 288,000. Crops in 1880: wheat, 10,128 acres; corn, 11,547 acres; number of forest trees, 285,155. For the year 1879, with seven miles of hedge: number of fruit trees—apple, 3,663; plum, 743; cherry, 544; peach, 27; pear, 24; 267 grapevines. For 1880: fruit trees, 1,811; forest trees, 1,340,000.

VIEW NEAR PLUM CREEK, DAWSON COUNTY, NEB.

Population from 1874 to 1880—

1874	2,842	1878	3,512
1875	2,886	1879	4,061
1876	3,263	1880	4,177

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Logan	99	757	Daily	299	713
Spring Bank	389		Silver Creek	414	
South Creek	130		North Bend	118	863
Otter Creek	177	692	Hookers	320	
Summer Hill	201		New Castle	441	
Galena	177		Iowa	241	
Clark	85		Ponca	1,170	1,167

Tax valuation—

In 1881 (estimated)	$1,072,939.00	In 1877 (actual)	$ 836,263.54
In 1880 (actual)	932,991.00	In 1876 "	730,515.80
In 1879 "	782,388.84	In 1865 "	587,331.00
In 1878 "	883,939.97		

Schools in 1880: number of districts, 55; children of school age, 1676; number of qualified teachers employed—males, 23, females, 48; value of school houses, $17,184.

DODGE COUNTY.

Organized 1855. Number of square miles, 540; acreage, 345.600; 1,176 feet above sea level. Crops in 1880—wheat, 43,712 acres; corn, 44,454 acres; number of forest trees, 59,457 for the year 1879, with 124 miles of hedge; number of fruit trees—apple, 20.082; plum, 11,271; peach, 10,359; cherry, 2,696; pear, 544; number of grapevines, 1,310. For 1880—fruit trees, 49.567; forest trees, 1,350.966.

Population from 1874 to 1880—

1874	6,893	1878	9,855
1875	7,534	1879	11,579
1876	8,465	1880	11,191

Population by precincts—

PRECINCTS.	1880.	1879.	PRECINCTS.	1880.	1879.
Fremont, First & Fourth Ward	1,809	1,235	Everett	950	918
Sec. & Third Ward	1,700	1,731	Maple	950	942
Elkhorn	950	346	Logan	950	1,011
Platte	950	687	Cuming	950	574
North Bend	950	996	Pebble	950	1,106
Union	959	766	Webster	950	879

Tax valuation—

In 1881 (estimated)	$2,725,660.00	In 1887 (actual)	2,096,119.80
In 1880 (actual)	2,370,139.23	In 1876 "	2,303,495.25
In 1879 "	2'261,010.06	In 1875 "	2,193,865.58
In 1878 "	2,319,530.49		

Schools in 1880—number of districts, 67; number of children of school age, 3,526; number of qualified teachers employed—males, 44; females,, 90; value of school houses, $47,520.

DOUGLAS COUNTY.

Organized in 1855. Number of square miles, 321; acreage, 195,440; 1,000 feet above sea level. Crops in 1880—wheat, 8,310 acres; corn, 31,834 acres; number of forest trees, 1,615,238. For the yeer 1879—number of fruit trees, 25,112. For 1880—forest trees, 28,112; fruit trees, 1,615,238.

Population from 1874 to 1880—

1874	22,670	1878	31,113
1875	24,698	1879	35,557
1876	25,722	1880	37,870

Population of Omaha by precincts—

CITY OF OMAHA.

PRECINCTS.	1880.	PRECINCTS.	1880.
First Ward	6,309	Fourth Ward	4,285
Second Ward	5,934	Fifth Ward	3,535
Third Ward	3,026	Sixth Ward	7,576

Population of Douglas county by precincts—

PRECINCTS.	1880.	PRECINCTS.	1880.
Saratoga	822	Chicago	604
Florence	620	Millard	602
Union	610	McArdle	540
Jefferson	409	Douglas	919
Elkhorn	430	West Omaha	660
PlatteValley	998		

Tax valuation—

In 1880	$7,866,831.97	In 1877	7,425,598.95
In 1881	9,046,856.00	In 1876	8,165,026.36
In 1879	7,582,087.14	In 1875	8,629,500.00
In 1878	7,342,382.22		

Schools in 1880—number of districts, 49; number of children of school age, 9,559; number of qualified teachers employed—males, 39; females, 103; value of school houses, $333,960.

Franklin County.

Organized in 1867. Number of square miles, 576; acreage, 368,640. Crops in 1880—wheat, 6,239 acres; corn, 4,501 acres; number of forest trees, 719,703 for the year 1879, with 16½ miles of hedge; number of fruit trees—plum, 8,549; peach, 5,079; apple, 2,130; cherry, 312; pear, 89, with 25½ acres of grapevines. For 1880—fruit trees, 6,386; forest trees, 154,940.

Population from 1874 to 1880—

1874	1,821	1878	2,656
1875	1,807	1879	4,137
1876	1,953	1880	5,470

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Grant	911	672	Bloomington	523	861
Salem	194	236	Macon	368	346
Buffalo	205	239	Ash Grove	407	271
Oak Grove	247	220	Washington	...	295
North Franklin	387	403	Lincoln	...	329
Turkey Creek	279	689	Antelope	...	158
Franklin	621	596	Marion	...	155

Tax valuation—

In 1881 (estimated)	$906,007.00	In 1877 (actual)	343,242.00
In 1880 (actual)	787,832.66	In 1876 "	372,473.76
In 1879 "	392,013.89	In 1875 "	358,939.00
In 1878 "	300,053.00		

Schools in 1880—number of districts, 43; children of school age, 1,452; teachers employed—males, 19; females, 25; value of school buildings, $4,535.

Fillmore County.

Organized in 1866. Number of square miles, 576; acreage, 368,640; 1,600 feet above sea level. Crops in 1880—wheat, 58,352; corn, 38,338 acres; number of forest trees, 1,181,134 for the year 1879, with 108 miles of hedge; number of fruit trees —peach, 24,954; apple, 14,037; plum, 11,727; cherry, 5,372; pear, 509; grapevines, 2,932. For 1880—fruit trees, 60,067; forest 3,775,958.

Population from 1874 to 1880—

1874	4,380	1878	9,556
1875	4,731	1879	8,760
1876	5,373	1880	10,212

Population by precincts—

PRECINCTS.	1879.	PRECINCTS.	1879.
Exeter	728	Bennett	443
Glengary	474	Bryant	369
Fairmount	1,126	Geneva	855
Chelsea	427	Hamilton	399
West Blue	575	Madison	497
Stanton	367	Belle Prairie	355
Grafton	612	Liberty	622
Momence	296	Franklin	515

Tax valuation—

In 1881 (estimated)	$2,027,446.00	In 1877 (actual)	1,305,657.20
In 1880 (actual)	1,762,997.30	In 1876 "	1,258,468.00
In 1879 "	1,603,470.60	In 1875 "	1,322,691.75
In 1878 "	1,606,962.20		

Schools in 1880—number of districts, 77; school houses, 74; number of children of school age, 3,089; number of qualified teachers employed—males, 40; females, 75; value of school houses, $36,733.

Frontier County.

Organized in 1872. Number of square miles, 972; acreage, 622,080.

Population from 1874 to 1880—

1874	128	1878	313
1875	139	1879	626
1876	243	1880	934

Tax valuation—

In 1881 (estimated)	$194,731.00	In 1877 (actual)	$ 42,615.00
In 1880 (actual)	169,333 00	In 1876 "	33,168.00
In 1879 "	86,475 75	In 1875 "	56,869.00
In 1878 "	57,642.75		

Schools in 1880: number of districts, eight; children of school age, 206.

Furnas County.

Organized in 1873. Number of square miles, 720; acreage, 460,800. Crops in 1880: wheat, 5,195 acres; corn, 4,760 acres; number of forest trees for 1879, 102,093; number of fruit trees—peach, 1,212; apple, 573; plum, 289; pear, 76; cherry, 49. For 1880: fruit trees, 5,227; forest trees, 118,197.

Population from 1874 to 1880—

1874	1,342	1878	1,810
1875	1,482	1879	2,982
1876	1,550	1880	6,406

Tax valuation—

In 1881 (estimated)	$694,725.00	In 1877 (actual)	$160,459.00
In 1880 (actual)	604,109.00	In 1876 "	215,158.00
In 1879 "	356,659.00	In 1875 "	202,504.00
In 1878 "	237,730.00		

Schools in 1880: number of districts, 56; children of school age, 1,455; number of qualified teachers employed—males, 19; females, 24; value of school houses, $2,968.

Gosper County.

Organized in 1877. Number of square miles, 468; acreage, 209,520. Crops in 1880: wheat, 1,116 acres; corn, 2,206 acres.

Population from 1874 to 1880—

1874	100	1878	813
1875	261	1879	622
1876	250	1880	1,674

Tax valuation—

In 1881 (estimated)	$ 86,859.00	In 1879 "	126,131.95
In 1880 (actual)	75,530.00	In 1878 "	117,173.67

Schools in 1880: number of districts, 18; children of school age, 371; number of teachers employed, 10.

Gage County.

Organized in July, 1859. Number of square miles, 680; acreage, 435,200; number of forest trees for 1879, 603,682, with 115 miles of hedge; number of fruit trees—peach, 42,865; apple, 27,641; cherry, 7,360. No returns reported for 1880.

Population from 1874 to 1880—

1874	5,290	1878	7,486
1875	5,714	1879	9,629
1876	6,021	1880	13,170

Population by precincts—

PRECINCTS.	1879.	PRECINCTS.	1879.
Beatrice	2,606	Rockford	507
Blue Springs	896	Grant	463
Clatonia	645	Highland	460
Paddock	598	Mud Creek	437
Blakeley	540	Adams	385
Cicily Creek	541	Nemaha	339
Liberty	526		

Tax valuation—

In 1881 (estimated)	$2,775,956.00	In 1877 (actual)	$1,943,253.12
In 1880 (actual)	2,413,875.81	In 1876 "	1,951,642.00
In 1879 "	2,054,574.05	In 1875 "	2,170,534.80
In 1878 "	2,084,854.20		

Schools in 1880: number of districts, 87; children of school age, 3,468; qualified teachers employed—males, 71, females, 67; value of school houses, $36,858.

Greeley County.

Organized in 1871. Number of square miles, 576; acreage, 368,640; 2,000 feet above sea level. Crops in 1880—wheat, 3,406; corn, 2,059 acres.

Population from 1874 to 1880—

1874	209	1878	473
1875	229	1879	753
1876	194	1880	1,460

Population by preciucts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Scotia	282	635	Spring Creek	146	526
Adell	79		O'Conner	140	
Cedar Valley	146	298			
Total population of County				793	1,459

Tax valuation—

In 1881	$297,094.00	In 1877	185,388.00
In 1880	258,343.00	In 1876	272,164.79
In 1879	194,866.00	In 1875	264,713.00
In 1878	200,588.00		

Schools in 1880—number of districts, 13; children of school age, 270; number of qualified teachers employed—males, 4; females, 10; total value of school property, $1,800.

Hall County.

Organized 1855. Number of square miles, 576; acreage, 368,640. Crops in 1880—wheat, 35,956 acres; corn, 15,649 acres;

1,850 feet above sea level; number of forest trees 1,262,294 for the year 1879, with 12 miles of hedge; number of fruit trees—plum, 10,165; apple, 6,266; peach, 4,559, cherry, 1,427; pear, 169; and 10 acres of grape vines. For 1880—fruit trees, 26,581; forest trees, 1,363,825.

Population from 1874 to 1880—

1874	3,942	1878	5,119
1875	4,414	1879	6,375
1876	4,615	1880	8,562

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Grand Island	2,200	3,551	Wood River	949	1,179
Prairie Creek	506		South Platte	704	
& Lake	....	563		....	1,267
Alda	913		Martinsville	271	
South Loup	832	1,028			
Total population of County				6,335	8,560

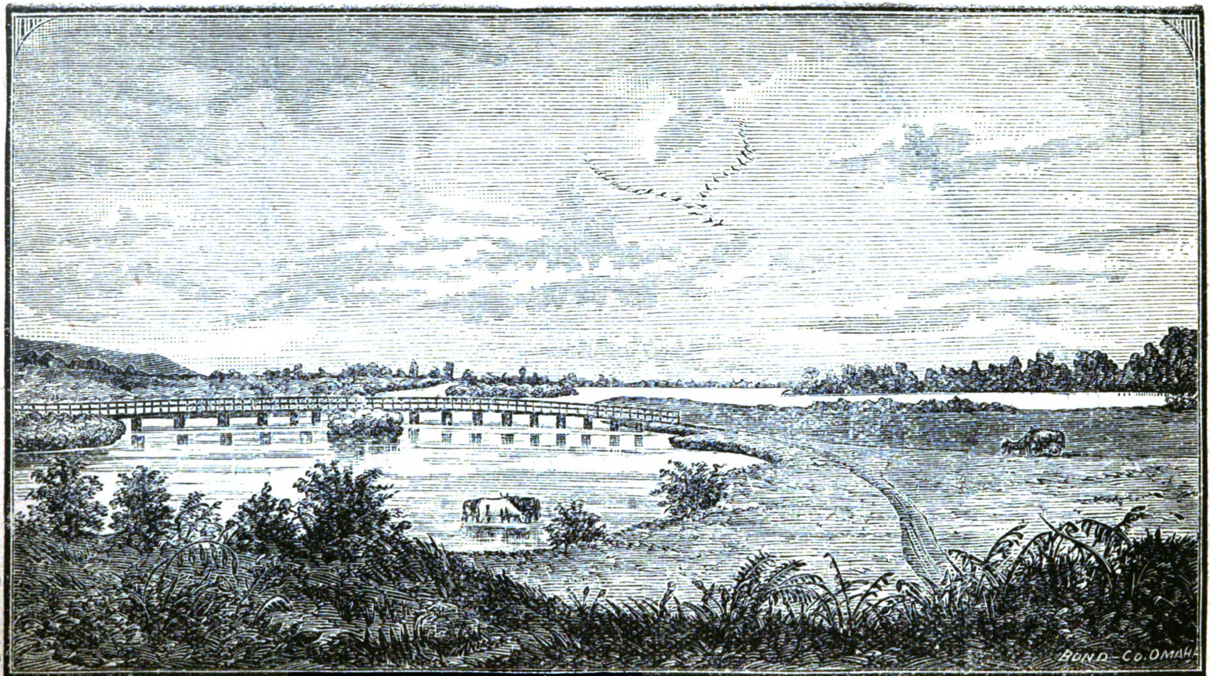
Tax valuation—

In 1881 (estimated)	$2,206,930.00	In 1877 (actual)	$1,608,025.60
In 1880 (actual)	1,919,070.00	In 1876 "	1,379,909.90
In 1879 "	1,815,280.60	In 1875 "	1,528,155.00
In 1878 "	2,712,733.80		

Schools in 1880—number of districts, 61; children of school age, 2,289; number of qualified teachers employed—males, 41; females, 48; value of school houses, $41,825.

Hamilton County.

Organized in 1867. Number of square miles, 560; acreage, 358,400; 1,800 feet above sea level. Crops in 1880: wheat, 42,616 acres; corn, 18,409 acres. Number of forest trees, 2,157,259 for the year 1879, with 43 miles of hedge; number of fruit trees—apple, 9,778; plum, 8,246; peach, 4,684; cherry, 1,792; pear, 243; and 395 grape vines. For 1880: fruit trees, 16,919; forest trees, 852,343.



VIEW IN HAMILTON COUNTY, SOUTH OF CENTRAL CITY, NEB.

Population from 1874 to 1880—

1874	3,186	1878	5,026
1875	3,526	1879	6,478
1876	6,253	1880	8,277

Tax valuation—

In 1881	$1,733,154.00	In 1877	$1,108,945.00
In 1880	1,507,090.62	In 1876	1,092,891.00
In 1879	1 228,792.00	In 1875	899,010.00
In 1878	1,188,038.00		

Schools in 1880: number of districts, 85; school houses, 71; children of school age, 2,707; number of qualified teachers employed—males, 41; females, 48: value of school houses, $21,901.

HARLAN COUNTY.

Organized in 1871. Number of square miles, 576; acreage, 368.640; number of forest trees, 260.321, with 19 miles of hedge; number of fruit trees—peach, 1,618; cherry, 963; apple, 780; plum, 142; pear, 29. No crop report for 1880.

Population from 1874 to 1880—

1874	1,847	1878	2,388
1875	2,027	1879	4,193
1876	2,140	1880	6,084

Population by districts for 1880—

No. 27—Republican City, by precinct enumeration	603
No. 28—Spring Brook and Prairie Dog, by precinct enumeration	739
No. 29—Sappa and Fairfield, by precinct enumeration	517
No. 30—Spring Creek, by precinct enumeration	592
No. 31—Orleans, by precinct enumeration	971
No. 32—Antelope, by precinct enumeration	598
No. 33—Washington, Turkey Creek and Mulalley, by prec't en.	1,080
No. 34—Alma, by precinct enumeration	705
No. 35—Albany, by precinct enumeration	265
Total	6,070

Tax valuation—

In 1881 (estimated)	$567,360.00	In 1877 (actual)	$201,457.84
In 1880 (actual)	493,356.57	In 1876 "	233,419.22
In 1879 "	257,897.47	In 1875 "	269,864.00
In 1878 "	251,085.17		

Schools in 1880: number of districts, 48; school houses, 30; children of school age, 1,396; whole number of children that attended school during the year, 569; number of qualified teachers employed, 46; males, 19; females, 27; value of school houses, $2,750.

Hitchcock County.

Organized 1873. Number of square miles, 720; acreage, 460,800.

Population from 1875 to 1880—

1875	95	1879	264
1876	90	1880	1,912
1878	132		

Tax valuation—

In 1881 (estimated)	$147,671.00	In 1877 (actual)	$55,423.00
In 1880 (actual)	128,419.00	In 1876 "	34,874.00
In 1879 "	165,101.00	In 1875 "	33,519.00
In 1878 "	78,242.50		

School in 1880—number of districts, 6; number of school children, 229; value of school houses, $375.

Holt County.

Organized in 1871. Number of square miles, 1,080; acreage, 691,200, with 10 miles of hedge. Crops in 1880—wheat 1,133 acres; corn, 3,069 acres. Number of apple trees, 26,680 for the year 1879. For 1880—fruit trees, 2,059; forest trees, 193,460.

Population—

1878	1,300	1880	3,231
1879	1.839		

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Paddock	537	911	Inman's Grove & Ford.	79	519
Steel Creek	171		Atkinson	176	.....
			Center	660	1,063
Keya Paha & Atkinson.	241	738	Ford	95	.....
Total population of County				1,959	3,231

Tax valuation—

In 1881 (estimated) ...	$146,995.00	In 4877 (actual)	$ 56,210.00
In 1880 (actual)	127,822.00	In 1876	....
In 1879 "	84,444.44	In 1875	....
In 1878 "	48,307.89		

Schools in 1880—number of districts, 21; school houses, 3; children of school age, 353; number of qualified teachers employed, 10.

HOWARD COUNTY.

Organized in 1871. Number of square miles, 566; acreage, 368,640. For 1880—number of fruit trees, 3,085; forest trees 469, 417, Crops in 1880—wheat, 16,748 acres; corn, 8,533 acres.

Population from 1874 to 1880—

1874	1,339	1878	2,329
1875	1,708	1879	3,246
1876	1,680	1880	4,410

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1779.	1880.
First	874	....	Sixth	423	....
Second	579	....	St. Paul & Spring Creek	....	1,548
Third	970	....	Danneborg & St Laborg	....	1,476
Fourth	185	....	Fairdale, Catesfield & Kelso	....	1,436
Fifth	170	....			
Population of County				1,880	4,420

Tax valuation—

In 1881	$707,194.00	In 1877	386,780.00
In 1880	674,952.00	In 1876	362,487.00
In 1879	392,256.00	In 1875	549,950.00
In 1878	363,550.00		

Schools in 1880—number of districts, 36; school houses, 29; children of school age, 1,114; number of teachers employed—males, 10; females 10; value of school houses, $9,890.75.

JEFFERSON COUNTY.

Organized in 1856. Number of square miles, 552; acreage, 353,280; 1,200 feet above sea level. Crops in 1880—wheat,

24,603 acres; corn, 21,794 acres; number of fruit trees—peach, 13,576; apple, 10,601; cherry, 2,751; plum, 1,906; pear, 216; grape vines 52 acres. For 1880—fruit trees, 283; forest trees, 1,051,000.

Population from 1874 to 1880—

1874	3,375	1878	5,016
1875	3,814	1879	6,280
1876	4,075	1880	8,123

Tax valuation—

In 1881 (estimated)	$1,557,783.00	In 1877 (actual)	$1,257,810.18
In 1880 (actual)	1,354,594.00	In 1876 "	1,230,107.20
In 1879 "	1,221,415.18	In 1875 "	1,263,797.30
In 1878 "	1,242,242.00		

Schools in 1880—number of districts, 68; school houses, 61; children of school age, 2,743, number of teachers employed—males, 21; females, 19; value of school houses, $27,120.

JOHNSON COUNTY.

Organized in 1855. Number of square miles, 378; acreage, 231,920; number of acres of forest trees, 1,400, with 647 miles of hedge; number of fruit trees—peach, 82,262; apple, 46,821; cherry, 8,054; plum, 1,957; pear, 974; and 6 acres of grape vine. No crop return for 1880.

Population from 1874 to 1880—

1874	4,644	1878	5,338
1875	4,862	1879	6,302
1876	4,908	1880	7,600

Tax valuation—

In 1881 (estimated)	$2,128,488.00	In 1877 (actual)	$1,158,551.88
In 1880 (actual)	1,850,859.32	In 1876 "	1,096,755.00
In 1879 "	1,201,164.92	In 1875 "	1,112,797.00
In 1878 "	1,228,957.32		

Schools in 1880--number of districts, 67: school houses, 65; children of school age, 2,922; number of teachers employed—males, 39; females, 66; valne of school houses, $24,300.

KEARNEY COUNTY.

Organized in 1859. Number of square miles, 505; acreage, 323,200; 2,100 feet above sea level. Crops in 1880—wheat, 14,102 acres; corn, 7,237 acres; number of forest trees, 668,944 for the year 1879, with 4 miles of hedge; number of fruit trees—peach, 1,696; apple, 1,185; plum, 255; cherry, 224; pear, 13. For 1880—fruit trees, 10,000; forest trees, 679,656.

Population from 1874 to 1880—

1874	327	1878	1,517
1875	560	1879	2,840
1876	803	1880	4,075

Tax valuation—

In 1881 (estimated)	$761,486.76	In 1877 (actual)	$448,217.88
In 1880 (actual)	662,162.40	In 1876 "	539,150.00
In 1879 "	428,814.25	In 1875 "	435,225.00
In 1878 "	471,337.57		

Schools in 1880—number of districts, 41; children of school age, 1,117; number of teachers employed, 23; value of school property, $4,375.

KEITH COUNTY.

Organized 1873. Number of square miles, 2,116; acreage, 1,290,240; 3,190 feet above sea level.

Population from 1874 to 1880—

1874	95	1878	137
1875	124	1879	274
1876	108	1880	191

Tax valuation—

1881	$681,791.00	1877	570,689.00
1880	592,862.00	1876	529,512.00
1879	564,894.00	1875	569,825.00
1878	549,872.00		

KNOX COUNTY.

Organized in 1859. Number of square miles, 1,075; acreage, 688,000. Crops in 1880—wheat, 5,122 acres; corn, 3,617 acres

number of acres of forest trees, 307. For the year 1879, number of fruit trees—apple, 830. For 1880—fruit trees, 1,015; forest trees, 573.

Population from 1874 to 1880—

1874	1,133	1878	1,446
1875	1,524	1879	2,088
1876	1,248	1880	3,664

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Niobrara	642	850	Western and Bohemia.	287 ...	832
Creighton	450	795	Verdigris	233	533
Eastern	307	416			
Central	179	238			

Tax valuation—

In 1881	$661,011.00	In 1877	$514,251.00
In 1880	574,793.00	In 1876	532,248.00
In 1879	458,222.00	In 1875	514,010.00
In 1878	591,443.00		

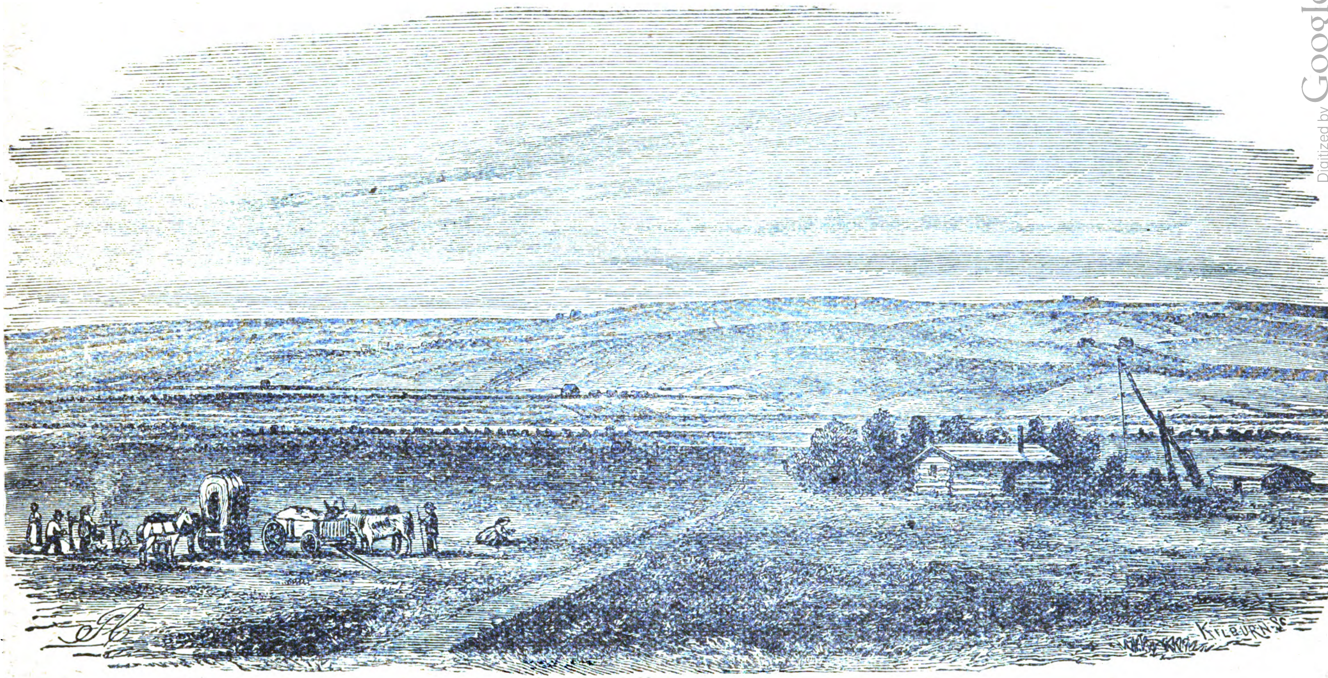
Schools in 1880—number of districts, 26; children of school age, 1,001; number of teachers employed—males, 12; females, 13; value of schoolhouses, $7,155.

Lancaster County.

Organized in 1855. Number of square miles, 864; acreage, 552,960; 1,114 feet above sea level Crops in 1880—wheat, 40,689 acres; corn, 89,179 acres; number of acres of timber, 4,000. For the year 1879, number of fruit trees—apple, 40,000; peach, 30,000; cherry. 10,000; plum, 7,000; pear, 4,000, with 300 miles of hedge. For 1880—fruit trees, 142,227; forest trees, 2,143,366.

Population from 1874 to 1880—

1874	14,308	1878	15,658
1875	15,224	1879	18,675
1876	15,407	1880	28,097



PRAIRIE, WITH CATTLE, NEAR WAVERLY, NEBRASKA.

Tax valuation—

In 1881	$5,668,790.00	In 1877	3,660,168.00
In 1880	4,929,383.07	In 1876	3,924,960.69
In 1879	3,762,039.00	In 1875	4,405,913.00
In 1879	3,752,865.30		

Schools in 1880—number of districts, 105; school houses, 107; children of school age, 7,476; number of qualified teachers employed—males, 48; females, 113; value of school houses, $52,040.

LINCOLN CONTY.

Organized 1859. Number of square miles, 2,592; acreage, 1,658,880; 2,789 feet above sea level.

Population from 1874 to 1880—

1874	2,555	1878	1,658
1875	2,855	1879	2,017
1876	1,327	1880	3,679

Population by precincts:

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
North Platte	1,593	1,924	Cottonwood Springs and Fox Creek	178	315
Brady Island and McPherson	72	156	O'Fallon's	65	284
Gannett	23		McPherson	86	
Total population of county				2,017	3,679

Tax valuation—

In 1881 (estimated)	$1,440,181.00	In 1877 (actual)	1,152,810.00
In 1880 (actual)	1,252,332.00	In 1876 "	1,177,299.82
In 1879 "	1,327,036.00	In 1875 "	1,166,526.00
In 1878 "	1,287,399.00		

Schools in 1880: number of districts, 8; children of school age, 865; number of teachers employed, 23; value of school houses, $16,955.

MADISON COUNTY.

Organized in 1856. Number of square miles, 576; acreage, 368,640; number of forest trees, 1,547,551 for the year 1879, 22 miles of hedge. Number of fruit trees—apple, 2718;

cherry, 758: peach, 267; pear, 33; and 38 acres of grape vines. No crop returns for 1880.

Population from 1874 to 1880—

1874	3,335	1878	3,683
1875	3,171	1879	4,280
1876	3,245	1880	5,587

Popoulation by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Center	414	842	Shell Creek	254	1,032
Fairview	272		Emerick	143	
Deer Creek	478	1,297	Schoolcraft	432	
Jefferson	456		Union Creek	874	1,200
Norfolk	957	1,216			

Tax valuation—

In 1881 (estimated)	$1,098,117.00	In 1877 (actual)	505,186.61
In 1880 (actual)	954,885.16	In 1876 "	603,654.25
In 1879 "	524,710.00	In 1875 "	653,447.50
In 1878 "	563,074.00		

Schools in 1880—number of districts, 54; children of school age, 1,787; teachers employed—males, 21; females, 39; value of school houses, $11,922.

MERRICK COUNTY.

Organized in 1858. Number of squre miles, 400; 1,686 feet above sea level. Crops in 1880: 13,597 acres of wheat; 11,575 acres of corn; number of fruit trees for the year 1879, 1,301,-390, with 11¾ mites of hedge. plum, 2,811—apple, 2,264; peach, 1,773; cherry, 166; pear, 64; grape vines, 284. For 1880: fruit trees, 11,052; forest trees, 1,287,628.

Population from 1874 to 1880—

1874	3,092	1878	3,786
1875	3,101	1879	4,025
1876	3,169	1880	5,341

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Silver Creek	368	419	Prairie Creek	406	491
Clarksville	831	873	Loup	365	410
Lone Tree	977	1,319	Central	144	146
Chapman	406	442	Vieregy	456	467
Prairie Island	56	107	Midland	288	332
Mead	328	326			

Tax valuation—

In 1881 (estimated)	$1,706,660.00	In 1877 (actual)	$1,355,864.60
In 1880 (actual)	1,484,053.00	In 1876 "	1,715,507.00
In 1879 "	1,886,999.60	In 1875 "	1,749,290.00
In 1878 "	1,377,254.80		

Schools in 1880: number of districts, 48; school houses, 43; children of school age, 1,823; number of teachers employed—males, 34; females, 45; value of school houses, $32,153.

NANCE COUNTY.

Organized in 1879. Number of square miles, 450; acreage, 288,000

Population from 1879 to 1880—

1879	1,000	1880	1,208

Population by precincts—

PRECINCTS.	1880.	PRECINCTS.	1880.
Fullerton Precinct	497	Cottonwood	90
Genoa	389	Loup Ferry	72
Timber Creek	160		
Total population of county			1,208

Tax valuation—

In 1881 (estimated)	$182,677.00	In 1879 (actual)	$ 30,094.00
In 1880 (actual)	158,850.00		

Schools in 1880: number of districts, 8; children of school age, 294.

NEMAHA COUNTY.

Organized in 1855. Number of square miles, 400; acreage, 256,000; number of forest trees, 1,178,767; fruit trees, 671,376. Crops in 1880—wheat, 22,942 acres; corn, 57,411 acres.

Population from 1874 to 1880—

1874	8,202	1878	9,017
1875	9,131	1879	10,504
1876	8,276	1880	10,458

Tax valuation—

In 1881 (estimated)	$2,124,327.00	In 1877 (actual)	$2,038,763.00
In 1880 (actual)	1,847,241.50	In 1876 "	2,302,928.00
In 1879 "	1,823,002.49	In 1875 "	2,302,452.00
In 1878 "	1,913,958.13		

Schools in 1880: number of districts, 75; school houses, 72; children of school age, 3;862; teachers employed—males, 26, females, 25; value of school houses, $45,558.

NUCKOLLS COUNTY.

Organized in 1859. Number of square miles, 576; acreage, 368,640; 1,600 feet above sea level. Crops in 1880—wheat, 9,475 acres; corn, 11,555 acres. Number of forest trees, 215,-779 for the year 1879, with 6½ miles of hedge. Number of fruit trees—apple, 4,222; peach, 5,618; cherry, 854; plum, 118; pear, 79; and 928 grape vines. For 1880: fruit trees, 20,705; forest trees, 233,384.

Population from 1874 to 1880—

1874	942	1878	2,159
1875	1,104	1879	2,964
1876	1,381	1880	4,233

Tax valuation.

In 1881 (estimated)	$1,318,255.00	In 1877 (actual)	848,602.57
In 1880 (actual)	1,146,309.00	In 1876 "	696,930.80
In 1879 "	880,908.09	In 1875 "	653,199.95
In 1878 "	841,597.18		

Schools in 1880—Number of school districts, 34; school districts, 34; school houses, 28; children of school age, 1,057; teachers employed—males, 24, females, 29; value of school houses, $12,095.

OTOE COUNTY.

Organized in 1855. Number of square miles, 575; acreage, 368,000. Crops in 1880—wheat, 24,706 acres; corn, 75,988 acres. Number of forest trees; for the year 1879, 2,166,838; number of fruit trees; 274,394. For 1880—fruit trees, 274,394; forest trees, 2,166,838.

Population from 1874 to 1880—

1874	12,380	1878	12,411
1875	13 270	1879	13,836
1876	11,756	1880	15,736

Tax valuation—

In 1881 (estimated)	$4,184,984.00	In 1877 (actual)	$4,010,213.49
In 1880 (actual)	3,595,639.10	In 1876 "	4,276,283.17
In 1879 "	3,279,104.77	In 1875 "	4,351,832.81
In 1878 "	3,249,024.38		

Schools in 1880. Number of districts, 85; school houses, 80; children of school age, 5,185; value of school houses, $38,725.

PAWNEE COUNTY.

Organized in 1855. Number of square miles, 432; acreage, 276,480. Crops in 1880: 8,198 acres of wheat; 35,156 acres of corn. Number of forest trees, 598,520, for the year 1879, with 425¼ miles of hedge: Number of fruit trees; peach, 71,237; apple, 42,515; cherry, 15,839; plum, 1,454; pear, 474; and 17,889 grape vines. For 1880—Fruit trees, 142,523: forest trees, 631,172.

Population from 1874 to 1880—

1874	5,057	1878	5,164
1875	4,881	1879	5,899
1876	4,783	1880	6,924

Population by precincts:

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Mission Creek	290	405	Clay	631	656
Plum Creek	328	426	Pawnee City	1,042	1,332
Turkey Creek	156	267	South Fork	745	714
West Branch	344	334	Sheridan	366	440
Miles	266	341	Table Rock	1,314	1,436
Steinauer	417	521			

Tax valuation—

In 1881 (estimated)..	$2,378,626.00	In 1877 (actual).....	1,174,821.19
In 1880 (actual)	2,068,370.96	In 1876 "	1,327,045.16
In 1779 "	1,144,506 77	In 1875 "	1,308,266.67
In 1878 "	1,149,385.31		

Schools in 1880--number of districts, 57; school houses, 56; children of school age, 2,612; teachers employed—males, 32; females, 52; value of school houses, $42,826.

PHELPS COUNTY.

Organized 1873. Number of square miles, 500; acreage, 320,000.

Population from 1874 to 1880—

1874	101	1878	326
1875	110	1879	1,275
1876	151	1880	2,447

Schools in 1880—number of districts, 23: school houses, 9; children of school age, 682; teachers employed, 17; value of school houses, $1,200.

PIERCE COUNTY.

Organized 1859. Number of square miles, 540; acreage, 345,600.

Population from 1874 to 1880.

1874	101	1878	326
1875	110	1879	1,275
1876	151	1880	1,215

Population by precincts:

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Dry creek	113	823	South Branch	260	
Pierce	87		Willow Creek	56.	
Slough	168				

Tax valuation:

In 1881 (estimated).....	$754,442.00	In 1877 (actual)........	$628,754.05
In 1880 (actual).......	656,037.00	In 1876 "	601,279.00
In 1879 "	634,653.00	In 1875 "	604,384.00
In 1878 "	835,003.00		

Schools in 1880—number of districts, 13; school houses, 10; children of school age, 308; teachers employed, 12; value of school houses, $8,174.

Platte County.

Organized in 1856. Number of square miles, 684; acreage, 437,760. Crops in 1880—wheat, 35,362 acres; corn, 20,553 acres. Number of acres of forest trees, 1,661$\frac{3}{4}$, for the year 1879, with 15$\frac{3}{4}$ miles of hedge; number of fruit trees—apple, 4,936; plum, 2,345; peach, 714; cherry, 557; pear, 51; grape vines, 40. For 1880—fruit trees, 12,964; forest trees, 1,964,000.

Population from 1874 to 1880—

1874	3,944	1878	6,045
1874	4,378	1879	7,587
1876	4,689	1880	9,554

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Granville	202	733	Bismarck	501	918
Pleasant Valley	309		Sherman	356	
Humphrey	324	684	Walker	312	732
Creston	205		Woodvillle	226	
Monroe	430	854	Shell Creek	373	799
Looking Glass	275		Stearns	340	
Lost Creek	510	1,230	Butler	622	851
Burrows	492		Columbus	2,210	2,656

Tax valuation—

In 1881 (estimated)	$2,511,026.00	In 1877 (actual)	$1,954,002.40
In 1880 (actual)	2,183,500.92	In 1876 "	1,770,696.0
In 1879 "	2,103,888.40	In 1875 "	1,818,300.00
In 1878 "	1,975,977.20		

Schools in 1880—number of districts, 64; school houses, 57; children of school age, 3,182; qualified teachers employed—males, 39, females, 43; value of school houses, $24,860.

Polk County.

Organized in 1856. Number of square miles, 425; acreage, 272,000; 1,600 feet above sea level. Crops in 1880—wheat, 38,-661 acres; corn, 22,457 acres. Number of forest trees, 1,124,610,


VIEW ON SHELL CREEK, PLATTE COUNTY, NEBRASKA.

for the year 1879, with 12 miles of hedge; number of fruit trees.—apple, 10,567; peach, 7,161; plum, 2,259; cherry, 1,227, pear, 221; grape vines, 2764. For 1880—fruit trees, 28,823, forest trees, 1,588,000.

Population from 1874 to 1880—

1874	2,764	1878	3,931
1875	3,031	1879	5,023
1876	3,356	1880	6,855

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Hackberry	695	827	Osceola	807	1,374
Canada	608	824	Valley	439	570
Clear Creek	339	403	Pleasant Home	664	875
Island	269	279	Platte	456	672
Stromsburg	746	1,019			

Tax valuation—

In 1881 (estimated)	$1,421,999.00	In 1877 (actual)	$905,309.00
In 1880 (actual)	1,236,521.00	In 1876 "	811,162.80
In 1879 "	950,295.00	In 1875 "	785,943.00
In 1878 "	933,329.00		

Schools for 1880. Number of districts, 58; school houses, 51; children of school age, 2,189; teachers employed—males, 49, females, 45; value of school houses, $21,610.

Red Willow County.

Organized in 1873. Number of square miles, 720; acreage, 460,800; number of forest trees, 25,170. Crops in 1880—wheat, 175 acres; corn, 587 acres.

Population from 1874 to 1880—

1874	545	1878	536
1875	694	1879	963
1876	663	1880	3,044

Tax valuation—

In 1881 (estimated)	$148,691.00	In 1877 (actual)	$65,302.00
In 1880 (actual)	129,297.00	In 1876 "	60,164.00
In 1879 "	73,741.00	In 1875 "	70,518.00
In 1878 "	66,010.00		

Schools in 1880—number of districts, 23; children of school age, 610; teachers employed—males, 8, females, 10.

SALINE COUNTY.

Organized in 1855. Number of square miles, 576; acreage, 368,640. Crops in 1880—47,541 acres of wheat; 45,637 acres of corn; number of forest trees, 1,835; for the year 1879—with 174 miles of hedges; number of fruit trees—apples 32,128; peach, 28,6s9; cherry, 9,135; plum, 3,509; pear, 854; 5,564 grape vines, for 1880; fruit trees, 83,189; forest trees, 1,302,462.

Population from 1874 to 1880—

1874	7,718	1878	10,453
1875	8,163	1879	12,417
1876	9,227	1880	14,493

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879	1880.
Crete	2,022	2,485	Wilber	1,388	1,481
Dorchester	673	954	Brush Creek	756	791
Lincoln	616	764	North Fork	626	992
Johnson Creek	1,062	1,235	Atlanta	446	548
Turkey Creek	607	655	Olive	234	} 952
Monroe	489	632	South Fork	562	
Pleasant Hill	918	1,013	Swan	487	513
Big Blue	818	782	DeWitt	713	886

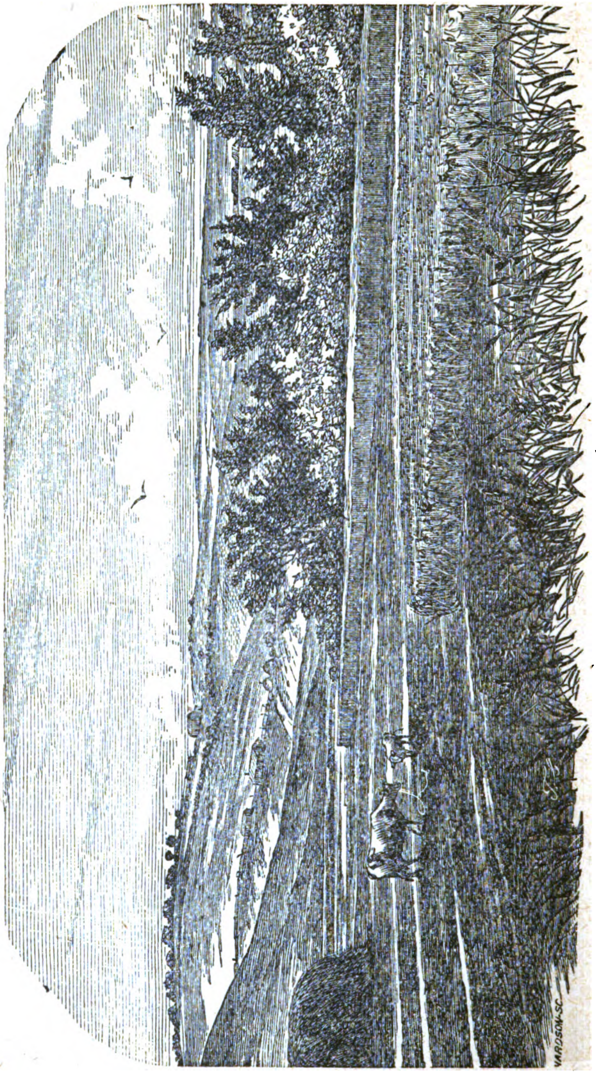
Tax valuation—

In 1881 (estimated)	$2,794,640.00	In 1877 (actual)	1,942,593.20
In 1880 (actual)	2,430,122.20	In 1876 "	2,100,785.40
In 1879 "	2,284,943.68	In 1875 "	1,921,429.00
In 1878 "	2,154,119.16		

Schools in 1880—number of districts, 106; school houses, 104 children of school age, 4,874; number of teachers employed—males, 68; females, 94; value of school houses, $54,713.

SARPY COUNTY.

Organized in 1855. Number of square miles, 275; acreage, 176,000. Crops in 1880: 8,502 acres of wheat; 26,040 acres of corn; number of acres of forest trees, 872; for the year 1879,



ON TURKEY CREEK, SALINE CO., NEB.

with 131¾ miles of hedge; number of fruit trees—apple, 27,-512; peach, 6,297; cherry, 4,305; plum, 1,127; pear, 810, and 9,-834 grape vines. For 1880, fruit trees, 33,952; forest trees, 1,-038,068.

Population from 1874 to 1880—

1874	3,164	1878	4,196
1875	3,385	1879	4,392
1876	3,735	1880	4,239

Population by precincts—

PRECINCTS.	1880.	PRECINCTS.	1880.
Bellevue	690	Richland	596
Papillion	926	Fairview	646
La Platte	384	Plattford	631
Forest City	495		

Tax valuation—

In 1881 (estimated)	$1,439,211.00	In 1877 (actual)	$1,463,242.55
In 1880 (actual)	1,251,488.70	In 1876 "	1,528,516.90
In 1879 "	1,295,780.28	In 1875 "	1,546,343.75
In 1878 "	1,308,634.44		

Schools in 1880—number of districts, 36; school houses, 35; number of children of school age, 1,600; number of teachers employed—males, 30; females, 19; value of school houses, $35,-140.

SAUNDERS COUNTY.

Organized in 1856. Number of square miles, 756; acreage, 483,840; 1,150 feet above sea level. Number of forest trees, 1,451,358, with 130 miles of hedge. Number of fruit trees—peach, 14,938; cherry, 8,716; plum, 8,035; apple, 4,762; pear, 1,059; and 6¾ acres of grape vines. No returns for 1880.

Population from 1874 to 1880—

1874	8,754	1878	12,514
1875	10,382	1879	13,528
1876	10,462	1880	15,827

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Oak Creek	414	602	Center	569	688
Newman	484	562	Cedar	687	818
Elk	783	857	Green	470	565
Chester	461	501	Wahoo	532	634
Bohemia	485	529	Marietta	492	576
Rock Creek	466	602	Pohocco	714	768
Chapman	507	638	Ashland	1,012	1,118
Mariposa	676	779	Clear Creek	551	723
Douglas	858	949	Marble	692	803
Richland	557	587	Union	658	704
Stocking	1,460	1,804			

Tax valuation—

In 1881 (estimated)	$2,544,659.00	In 1877 (actual)	$2,121,514.79
In 1880 (actual)	2,212,747.46	In 1876 "	1,867,231.60
In 1879 "	1,938,734.59	In 1875 "	1,812,692.00
In 1878 "	2,117,631.19		

Schools in 1880—number of districts, 102; school houses, 93; children of school age, 5,367; number of teachers employed—males, 70; females,, 95; value of school houses, $50,130.

SEWARD COUNTY.

Organized in 1855. Number of square miles, 576; acreage, 468,640. Crops in 1880: wheat, 53,897 acres; 67,294 acres of corn; number of acres of forest trees 4,000.. For the year 1879—number of fruit trees, 42,900. For 1880: fruit trees, 53,176; forest trees, 1,053,853

Population from 1874 to 1880—

1874	7,429	1878	7,991
1875	6,601	1879	9,389
1876	6,875	1880	11,095

Census Returns by Districts, 1880—

ENUMERATION DISTRICT.	NUMBER OF INHABITANTS	ENUMERATION DISTRICT.	NUMBER OF INHABITANTS.
		140	552
132	292	141	638
133	495	142	467
134	688	143	566
135	635	144	595
136	744	145	640
137	555	146	1,035
138	874	147	430
139	586	148	1,324

Grand Total 11,118

Tax valuation—

In 1881 (estimated)	$2,342,938.00	In 1877 (actual)	$1,372,792 40
In 1880 (actual)	2,037,337.79	In 1876 "	1,613,659.00
In 1879 "	1,628,492.29	In 1875 "	1,519,243.00
In 1878 "	1,609,449.70		

Schools in 1880—number of districts, 86; school houses, 83; children of school age, 3,870, number of teachers employed—males, 55; females, 79; value of school houses, $35,588.

Sherman County.

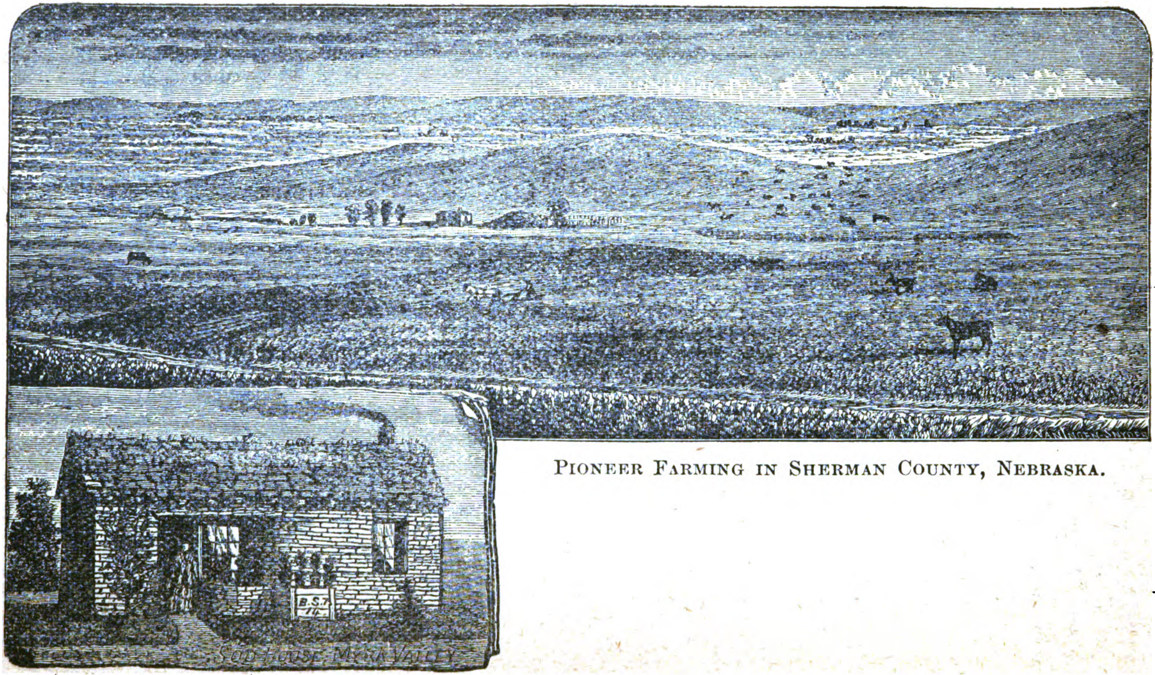
Organized in 1871. Number of square miles, 576; acreage, 368,640. Crops in 1880—3,642 acres of wheat; 2,538 acres of corn; number of forest trees, 106,300, for the year 1879. For 1880—fruit trees, 523; forest trees 1,467.

Population from 1874 to 1880—

1874	460	1878	594
1875	496	1879	1,120
1876	561	1880	2,061

Population by precincts—

PRECINCTS.	1779.	1880.	PRECINCTS.	1879.	1880.
Lower Loup	187		Upper Loup	456	817
Oak Creek		522	Hayestown	145	722
Deer Creek	129		Clear Creek	302	



Pioneer Farming in Sherman County, Nebraska.

Tax valuation—

In 1881	$315,335.00	In 1877	297,151.00
In 1880	274,205.00	In 1876	468,977.00
In 1879	156,903.75	In 1875	180,082.00
In 1878	103,759.00		

Schools in 1880—number of districts, 29; school houses, 19; children of school age, 586; value of school houses, $2,664.

RICHARDSON COUNTY.

Organized in 1855. Number of square miles, 550; acreage, 352,600; forest trees, 1,084,169. Crops in 1880—28,860 acres of wheat; 74,430 acres of corn; number of forest trees, 2,827,-816 for the year 1879, with 949½ miles of hedge; number of fruit trees—peach, 118,466; apple, 101,229; cherry, 13,944; plum, 2,901; pear, 2,365; grape vines, 13,619. For 1880—fruit trees, 299,078.

Population from 1874 to 1880—

1874	15,000	1878	12,509
1875	15,000	1879	13,044
1876	11,327	1880	15,034

Population by precincts—

PRECINCTS.	1879.	PRECINCTS.	1879.
Arago	798	Nemaha	546
Barada	1,137	Ohio	855
Falls City	2,651	Porter	448
Franklin	447	Rulo	1,205
Grant	739	Saline	807
Humboldt	1,253	Spicer	644
Liberty	622	St. Stephens	464
Muddy	721		

No returns for 1880.

Tax valuation—

In 1881 (estimated)	$3,256,267.00	In 1877 (actual)	$2,647,005.30
In 1880 (actual)	2,831,537.28	In 1876 "	2,898,087.16
In 1879 "	2,556,705.43	In 1875 "	2,888,781,89
In 1878 "	2,717,839.37		

Schools in 1880: number of districts, 98; school houses, 92; children of school age, 5,721; teachers employed—males, 69; females, 75; total value of school houses, $54,875.

Washington County.

Organized 1855. Number of square miles, 400; acreage, 256,000. Crops in 1880—wheat, 2,412 acres; corn, 36,564 acres; number of acres of forest trees, 1,840½, with 24½ miles of hedge; number of fruit trees—apple, 59,629; cherry, 9,960; peach, 3,287; plum, 3,277; pear, 1,819; and 19,013 grapevines.

Population from 1874 to 1880—

1874	5,304	1878	7,116
1875	6,114	1879	8,361
1876	6,286	1880	8,650

Population by precincts—

PRECINCTS.	1880.	PRECINCTS.	1880.
Blair	2,212	Fontenelle & Sheridan.	1,322
Bell Creek & Richland.	1,369	Grant & Lincoln	1,319
Ft. Calhoun & De Soto.	1,026	Cuming City & Herman.	1,221

Tax valuation—

In 1881 (estimated)	$1,907,596.00	In 1877 (actual)	$1,505,007.88
In 1880 (actual)	1,658,779.49	In 1876 "	1,551,736.00
In 1879 "	1,481,733 89	In 1875 "	1,600,041.00
In 1878 "	1,672,482.84		

Schools in 1880—number of districts, 45; number of children of school age, 2,883; qualified teachers employed, 79—males, 23; females, 56; value of school houses, $43,470.

Stanton County.

Organized in 1861. Number of square miles, 432; acreage, 276,480. Crops in 1880—wheat, 6,056 acres; corn, 7,154 acres; number of forest trees, 1,100,500 for the year 1879, with 12 miles of hedge; number of fruit trees—apple, 468; cherry, 35;

peach, 34; plum, 21; pear, 3, and 7 acres of grape vines. For 1880—fruit trees, 2,247; forest trees, 813,200.

Population from 1874 to 1880—

1874	1,135	1878	1,410
1875	1,158	1879	1,486
1876	1,223	1880	1,813

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Stanton	1,106	1,383	Humbug	217	430
			K'gsbury	163	

Tax valuation—

In 1881 (estimated)	$702,965.00	In 1877 (actual)	$595,881.00
In 1880 (actual)	611,274.00	In 1876 "	607,408.50
In 1879 "	608,320.00	In 1875 "	597,407.00
In 1878 "	625,754.98		

Schools in 1880—number of districts, 22; school houses, 21; children of school age, 599; teachers employed, 29—males, 20; females, 9; value of school houses, $10,631.08.

THAYER COUNTY.

Organized 1856. Number of square miles, 576; acreage, 368,640. Crops in 1880—wheat, 17,413 acres; corn 14,705 acres; number of forest trees, 21,798 for the year 1879, with 22 miles of hedge; number of fruit trees—peach, 13,930; apple, 5,996; cherry, 2,494; plum, 1,690; pear, 72, and 1,641 grapevines. For 1880—fruit trees, 52,988; forest trees, 853,858.

Population from 1874 to 1880—

1874	1,781	1878	3,391
1875	2,139	1879	4,535
1876	2,410	1880	6,129

Tax valuation—

In 1881 (estimated)	$1,670,271.50	In 1877 (actual)	918,485.65
In 1880 (actual)	1,452,410.00	In 1876	1,022,014.00
In 1879	1,074,905.15	In 1875	1,079,239.75
In 1878	947,299.00		

Schools in 1880—number of districts, 52; school houses, 46; children of school age, 1,579; teachers employed—males, 34; females, 35; value of school houses, $23,748.

VALLEY COUNTY.

Organized in 1871. Number of square miles, 576; acreage, 368,640. Crops in 1880—wheat, 1,675 acres; corn, 617 acres. Number of forest trees, 165,985 for the year 1879, with 2½ miles of hedge; number of fruit trees—apple, 627; peach, 575; plum, 211; cherry, 54. For 1880—fruit trees, 1,324; forest trees, 181,851.

Population from 1874 to 1880—

1874	264	1878	1,075
1875	287	1879	1,540
1876	749	1880	2,334

Population by precincts—

PRECINCTS.	1879.	1880.	PRECINCTS.	1879.	1880.
Ord, Calamus, Spring Lake	700	1,017	North Loup, Myra Creek	600	752
Liberty, Arcadia	500	565	Population of Co	1,800	2,334

Tax valuation—

In 1881 (estimated)	$444,945.00	In 1877 (actual)	$316,139.00
In 1880 (actual)	386,907.00	In 1876	328,806.75
In 1879 "	326,768.00	In 1875	338,824.00
In 1878 "	280,539.00		

Schools in 1879—number of districts, 19; number of school houses, 14; children of school age, 476; qualified teachers employed, 16; males, 6; females, 10; value of school houses, $5,126.35.

Schools in 1880—number of districts, 30; number of school houses, 16; children, of school age, 729; number of teachers employed, 22; value of school houses, $7,261.

WEBSTER COUNTY.

Organized in 1867. Number of square miles, 576; acreage, 368,640. Crops in 1880—wheat 17,271 acres; corn, 13,742 acres; number of forest trees, 860,609, with 10 miles of hedge; number of fruit trees—peach, 10,083; apple, 8,369; cherry, 1,034; plum, 683; pear, 112. For 1880—fruit trees, 21,744; forest trees, 620.592.

Population from 1874 to 1880—

1874	2,250	1878	4,341
1875	2,590	1879	5,947
1876	2,962	1880	7,197

Population by precincts—

PRECINCTS.	1879.	PRECINCTS.	1879.
Oak Creek	403	Elm Creek	331
Glenwood	335	Inavale	430
Stillwater	451	Guide Creek	721
Batin	249	Pleasant Hill	288
Harmony	449	Potsdam	345
Walnut Creek	333	Red Cloud	1613

No Census Report for 1880.

Tax valuation—

In 1881 (estimated)	$1,090,578.00	In 1877 (actual)	836,263.54
In 1880 (actual)	948,528.89	In 1876 "	730,515.80
In 1879 "	782.388.84	In 1875 "	587,331.00
In 1878 "	883,935.97		

Schools in 1880—number of districts, 70; school houses, 48; children of school age, 2,218, teachers employed—males, 34; females, 42; value of school houses, $11,857.

WAYNE COUNTY.

Organized in 1871. Number of square miles, 448; acreage, 286,720. Crops in 1880—wheat, 1,826 acres; corn, 2,377 acres; number of forest trees, 126,637 for the year 1879, with 7¾ miles of hedge; number of fruit trees—plum, 663; apple, 657; peach, 325; cherry, 243; pear, 11, and 32 grapevines. For 1880—fruit trees, 5,227; forest trees, 654,000.

Population from 1874 to 1880—

1874	272	1878	386
1875	431	1879	481
1876	299	1880	805

Population by precincts—

PRECINCTS.	1879.	1880.
La Porte & Leslie.	228	634
Spring Branch	119	171
Leslie	134	..

Tax valuation—

In 1881 (estimated)	$686,163.00	In 1877	$588,266.19
In 1880 (actual)	596,664.00	In 1876	577,951.51
In 1879	482,059.88	In 1875	594,892.35
In 1878	539,997.38		

Schools in 1880—number of districts, 11; school houses, 8; children of school age, 169: teachers employed, 13—males, 7; females, 6; total value of school property, $6,099.50.

YORK COUNTY.

Organized in 1867. Number of square miles, 576; acreage, 368,640; 1,600 feet above sea level. Crops in 1880—73,920 acres of wheat; 59,440 acres of corn; number of acres of forest trees, 1,914. For the year 1879—number of fruit trees—apple, 13,692; peach, 8,720; cherry, 3,180; plum, 1,642; pear, 402; and 3,068 acres of grape vines. For 1880—fruit trees, 52,445; forest trees, 2,253,758.

Population from 1874 to 1880—

1874	4,593	1878	7,348
1875	5,266	1879	9,112
1876	5,921	1880	11,171

Population by precincts—

PRECINCTS.	1879.	PRECINCTS.	1879.
Stewart	885	York	1,879.
Houston	737	West Blue	1,035
North Blue	776	Woodruff	930
Baker	905	Henderson	1,070
Beaver Creek	952		

No census returns by precincts for 1880.

Tax valuation—

In 1881 (estimated)	$3,471,475.00	In 1877 (actual)	$ 997,456.00
In 1880 (actual)	3,018,673.95	In 1876 "	1,033,022.50
In 1879 "	1,278,953.02	In 1875 "	1,100,658.00
In 1878 "	1,238,169.26		

Schools in 1879: number of districts, 84; school houses, 69; children of school age, 3,285; teachers employed—males, 47; females, 75; value of school houses, $21,495.72.

Population of Border Counties and Unorganized Districts.

CHASE COUNTY.

Organized in 1873. Number of square miles, 936; acreage, 569,040.

DUNDY COUNTY.

Organized 1873. Number of square miles, 936; acreage, 599,040.

HAYES COUNTY.

Organized in 1877. Number of square miles, 720; acreage 460,800.

SIOUX COUNTY.

Organized in 1877. Number of square miles, 7,344; acreage, 4,700,160.

Population by divisions—

FIRST DIVISION.—All territory lying north of Cheyenne county and south of the Niobrara river, west of the 5th guide meridian and east of State boundary, in 1880, had a population of 104.

SECOND DIVISION.—All territory north of the Niobrara river and south of the State line, west of the 6th guide meridian, east of the western boundary of the State, in 1880, had a population of 331.

THIRD DIVISION.—All territory north of the Niobrara river, south of State line, between 5th and 6th guide meridian, in 1880, had a population of 264.

Population of county, 699.

WHEELER COUNTY.

Organized in 1877. Number of square miles, 1,155; acreage, 737,280.

Population by precincts—

FIRST PRECINCT.—All territory lying east of Cedar Creek, in 1880, had a population of 600; in 1879, 304.

SECOND PRECINCT.—All territory lying west of Cedar Creek, in 1880, had a population of 600; in 1879, 340.

Population of county, in 1880, 1,200; in 1879, 644.

UNORGANIZED DISTRICTS.

All territory south of State boundary north of the 6th standard parallel, between 4th and 5th guide meridian, 71.

All territory south of 6th standard parallel, north of Keith and Lincoln counties, between 4th and 5th guide meridian, 68.

All territory south of State line, north of the North Loup River, between 3d and 4th guide meridian, 1,118.

All territory south of North Loup River and north of Middle Loup River, between 3d and 4th guide meridian, 109.

All territory south of Middle Loup River, north of Dismal River, between 3d and 4th guide meridian, 118.

All territory south of Dismal River, north of Lincoln county, between 3d and 4th guide meridian, 99.

All territory south of State boundary, north of Niobrara River, between 2nd and 3d guide meridian, 292.

All territory south of Niobrara River, north of the 7th standard parallel, between 2nd and 3d guide meridian, 503.

All territory south of 7th standard parallel, north of Calamus River, between 2nd and 3d guide meridian, 123.

All territory south of Calamus River, north of North Loup River, between 2nd and 3d guide meridian, 70.

All territory south of North Loup River, north of Custer county, between 2nd and 3d guide meridian, 345.

OMAHA INDIAN RESERVATION.

Population for 1880, 108.

CHAPTER XIII.

Farms and Farming in Nebraska—Theory and Practice—The Law of Farm-making—Growth of Cereals—King Corn—Corn Culture—The Model Cornfield—100 Bushels per Acre—The Law of Culture—The Law of Heredity or Pedigree—The Law of Locality or Environment—Profits of Corn Culture.

AFTER noting the preceding pages of crop statistics there is certainly no need of separate or special description of soils in any part of Nebraska.

From partial crops, one may probably infer poor farming, or an unfavorable season, as the proximate cause, but he can not attribute light crops to any lack of productive ability or fertility of soil. In the West indifferent or poor soils are an exception. Whether they are crushed ground, washed and distributed by glacial agencies or spread far and wide by the aqueous forces of modern drift, or precipitated like chalk or loess,—they appear to be perfectly pre-adapted to, and instantly ready for the growth of grains, grasses, shrubs and trees.

This wonderful co-ordination or adaptation may be seen by examining the analysis of soil from any region, and comparing it with the constituents or mineral elements of plants. For instance, one of Prof. Aughey's analysis of Nebraska soils reads as follows:

Insoluble siliceous matter, 63.07; ferric oxide, 2.85; alumina, 8.41; lime carbonate, 7.08; lime phosphate, .90; magnesia carbonate, 1.41; potash, .50; soda, .49; sulph. acid, .79; organic matter, 14.00; loss, .50.

Arend gives the analysis of the ashes of 1,000 plants, when in fruit, as follows:

Silica, 3.632; sulph. acid, 5.34; phosphoric acid, 14.00; oxide of iron, .58; lime, 14.71; magnesia, 6.45; chlorine, 5.78; soda, .87; potash, 43.76.

We can not study these two chemical correlations or counterparts without perceiving the immense range for experiment and development that must exist in the powers of both soil and plants. Our farmers and our educators in agriculture and horticulture have this entire domain in their undisputed possession. We must study these relations each state by itself and compare the result year by year before we shall know the capacity or value of our soil in the products of the farm or garden. "Who are the farmer's servants? Who but geology, chemistry, the quarry of the air, the water of the cloud, the plough of the frost? Before he was born into the field the sun of ages soaked it with light and heat; mellowed his land, decomposed the rocks, covered it with vegetable film, then with forests and accumulated cubic acres of sphagnum whose decay makes the peat of his meadow. The rocks crack like glass by inequality of contraction in heat and cold, and snow flakes fall constantly into the soil. The tree can draw on the whole air; the whole earth on all the rolling main. The plant, the tree, is all suction-pipe, imbibing from the ground by its roots, from the air by its twigs with all its might. Take up a spade-full of loam; who can guess what it holds? But a gardener knows that it is full of peaches, full of oranges, and he drops in a few seeds, by way of keys, to unlock and combine its virtues; lets it lie in the sun and rain, and by and by it has lifted into the air its full weight in golden fruit. What agencies of electricity, gravity, light, affinity, combine to make every plant what it is, and in a manner so quiet that the presence of these tremendous powers is not ordinarily suspected. The ripe fruit is dropped without violence, but the lightning fell and the storm raged, and the strata were despoiled and uptorn and beat back, and chaos moved from beneath to create and flavor the fruit on your table."

There are certain inevitable obstacles that must be overcome in making either a farm or garden. In the vast wooded districts of the Middle and Eastern States, during the period of early settlement, the pioneer and farmer was obliged to take four steps in order to realize and enjoy a farm.

First. The forest must be leveled and the trees consumed.

Second. The stumps must be disposed of, either by slow decay, requiring years of patient waiting and partial cultivation, or by the more expensive method of digging, or extracting by machinery.

Third. The roots must be taken out in a similar manner.

Fourth. The soil must then be deep plowed and mixed with fertilizers, according to its need for the crop required of it.

The time thus required to overcome the wooden wilderness varies from fifteen to twenty-five years. The average time for Ohio farms is near twenty years, on account of the general rule adopted by farmers of waiting for decay, in this way saving for the soil some portion of the carbonous matter of decaying trees. Several instances are known of wealthy men who have crowded three-fourths of this work into a single year, at a cost of $50 to $100 per acre; but the pioneer is obliged to wait upon the order of nature, and expend his life force in making a farm and home remunerative.

In the prairie or unwooded region of the United States and Territories many erroneously suppose that having no forests to clear away, the prairie can be at once converted into a farm. But such is not the case. Nature has her bond upon the plains of Nebraska and Kansas as well as in the woods of Ohio and Michigan, to be released only by conformity to the great law of labor.

1st. The prairie sod, or turf, must be broken and disposed of by slow decay. This requires two years.

2nd. The soil must be also deep-ploughed and exposed to the rains in order to be well supplied with moisture. From the first year, however, fair crops can be raised.

3d. After five to seven years preparation the farm is ready for any crop service.

There are no profits from farming in any country unless the soil has been thoroughly subdued as a basis. All work done or required to be done to bring about this subjection, if it takes five

or seven years in the trans-Missouri States, is well compensated if the farmer, during the period, succeeds in paying living expenses and meeting the payments and the ordinary bills for improvements.

But once ready, the prudent farmer has no need of guarantees for complete success. With the average season his fortune is secure. Hence it is that those who have the "staying qualities," even in the midst of severe temporary discouragements, are certain to have a competence. It is the fulfillment of the promise "we shall reap if we faint not."

Many of the farmers of Nebraska have not been wanting in industry. They say "we have worked incessantly, and in some instances with indifferent crops." If one crop would not grow profitably they try another, then another, and so on until the catalogue is exhausted; or they will persevere year after year, reckoning on the luck of a season to turn in their favor. Yet all this time they did not perceive that they had neglected the demands of the soil, to which they were unused. It requires deep plowing, early and deep planting and sowing, and subsequent careful cultivation. So many farmers in Nebraska have already struck this the key note of the performance in all parts of the State, without regard to locality, that poor crops can no longer be referred to any other cause than the farmer himself.

Even if there were only one thoroughgoing intelligent farmer in a township, with splendid crops, in the midst of a hundred farms deficient in good results, we are forced to say that nature is impartial—that she has dispensed rain and sunshine not to favor a prosperous farmer. The higher truth is evident—this farmer has subdued his farm, and knows it thoroughly. He observes the times and seasons—when and how to plow, plant, sow and cultivate. If he is favored with 60 and 100 fold, let him that has only 30 fold go and do likewise.

Declining to compass or discuss the best methods of raising cereals in Nebraska, because beyond the limits intended in this

volume, it may serve a practical purpose to note the relations of our soil to the culture of corn:

Our corn plant or Zea mais, is one of the cultivated grasses. This is also true of wheat, oats, rye, barley and timothy; and because these grasses furnish food in some manner for the animal kingdom, we can very properly say that "all flesh is grass."

In its present appearance a stalk of corn is more like a tree than a stem of grass. In many points of resemblance it could be located half way between the blue joint and the magnificent palm.

In its manifold uses, not including those that are now in course of experiment, and in greatly increased production and demand it is to-day the most important of all our farm products. It is the daily bread of millions; and because it sustains a large proportion of humanity, in the temperate zones, it is with its progressive culture, more properly than any other the food of civilized man. It not only supports man, but his best servants, his flock of sheep and herds of swine and cattle and beasts of burden.

It gives not only bread and sugar and furnishes us with a bed, but made into paper boards it now gives us a dwelling. In recent uses, such as roofs, siding, car wheels, boards, boxes, printing paper, &c., &c., it is more inviting in the way of experiment and discovery than any other product of the soil.

In the States of the West and Northwest it has become in agriculture the basis of prosperity to such an extent that the ability of a State to produce corn is the prime factor of its progress.

The modes of increasing the quantity and quality of our corn product, or the yield of corn per acre, must therefore be considered a question of first importance in western agriculture.

The Agricultural Department at Washington gives the following as estimates of the crops of the United States for the present year:

Crop.	Product.	Acres.
Wheat, bu	448,750,000	32,545,900
Corn, bu	1,601,151,570	53,086,401
Oats, bu	365,000,000	12,683,500
Rye, bu	23,646,000	1,635,400
Barley, bu	40,184,000	1,680,000
Buckwheat, bu	11,960,000	640,200
Potatoes, bu	181,369,340	1,836,820
Tobacco, lbs	394,056,659	493,167
Cotton, bales	4,926,285	12,595,510

It has nearly four times the yield of wheat, although from the corn area only 30 bushels per acre average are produced. It is also seen that the amount raised in 1880 would distribute, according to the census, 30 bushels to each person.

The corn product in 1850 was 592,071,104 bushels; in 1860, 838,792,742 bushels; in 1870, 760,944,549 bushels; in 1880, 1,501,-151,570 bushels, from 53,185,401 acres.

The population of the United States in 1860 was 31,443,321; in 1880, 50,858,000.

Corn, in 1860, 839,000,000 bushels; in 1881, 1,601,151,570 bushels.

It will be seen by comparison that corn has such a ratio of increase as to warrant for 1890 the enormous product of 3,000,-000,000 of bushels.

The corn producing capacity per acre, with average seed, can be readily estimated, as follows:

In one average bushel of corn there are 63,000 kernels. In one average bushel of wheat there are 736,840 kernels.

Of several thousand ears of corn, in Nebraska, (product of 1880) the following will give average of the best cultivated fields:

Yield of Corn Per Ear.

						Kernels.
1st.	14	rows,	57	kernels	each	798
2d.	12	"	56	"	"	672
3d.	19	"	54	"	"	1,026
4th.	15	"	50	"	"	800

6th.	14	"	38	"	"	518
7th.	13	"	65	"	"	845
8th.	18	"	60	"	"	1,080
9th.	24	"	60	"	"	1,440
10th.	..		..			1,300

In one acre of land there are 4,840 square yards, or 3x3 ft. spaces, or 2,722 4x4 ft. spaces, or 1,742 5x5 ft. spaces. Estimating 4 ears of corn per hill of corn planted 4 feet apart, and counting only 600 kernels per ear, we have 2,400 kernels; multiplied by 2,722, the number of hills per acre, gives 6,532,800 kernels, or a little over 100 bushels per acre. This estimate is based upon the small-sized ears of corn, leaving for increased production, by careful experiment, a wide margin for such improvements as can be made by the culture of seed. Thus, 100 bushels of corn per acre is a low estimate, when we consider all the factors that can be utilized by farmers for its increased proproduction.

The Law of Heredity or pedigree in seed is one of the chief factors in increasing our corn product. This law may be stated in a more simple and comprehensive form, viz: Like produces like.

"Many years ago, and in a period of our agricultural history when new varieties of any farm crop were extremely rare, an observant farmer of Pennsylvania, acting on the principle that perfect grain could only be insured by using perfect seed, originated a superior variety of wheat, which he named "barrel wheat." This he did by holding the sheaves of wheat in his hand by the butts and beating the tops over a barrel. The large, plump, perfect grains would fly out, and none others. This wheat was used as seed, and the same practice to procure seed being followed a few years produced what seemed to be a new variety of wheat, but what was only the result of a practical application of the natural law of selecting the fittest. This anecdote is a practical illustration of using none but the very best for seed."

The subject of pedigree in seeds, though not entirely new, has only recently attracted attention to its value in the business of farming. Major Hallett, of Brighton, England, has been the first to call attention to its importance, as far as cereals are concerned. He says that in the course of his studies he has ascertained, beyond all doubt, the three following facts:

1st. That no two grains of any cereal, (wheat, corn, oats, barley, etc.,) will produce plants precisely equal.

2d. That, in the grains from any one ear, there is one which is superior to all the others in producing power, and that this superiority is inheritable.

3d. That it may, by repeated selections from year to year, of the best selected grain, be greatly increased, and finally become characteristic of the plant.

In proof of the correctness of these principles, he says he took two grains from two ears of wheat which together contained 87 grains. One of these grains produced a plant of ten ears, which contained 688 grains, or over 68 grains to an ear, while the finest 10 ears which could be selected from the remaining 85 grains contained 598 grains, or exactly 10 grains less than the two selected grains. A plant of barley, grown from a single grain, produced fifty ears. One has a record of being an extraordinary ear, all of whose grains are short, plump, thin-skinned and beautiful. This was classed No. 1. There was an evident tendency in all other ears to produce elongated grains of not so good a color, and with thicker skins. Of these fifty ears, the grains from the best each ten were planted in separate divisions. These were submitted to the inspection of an eminent maltster, who could scarcely believe that all the samples originated from one grain, and he selected as the best sample ears from the one which produced such superior ears. This produced barley which exceeded the other in weight by three pounds to the bushel. Major Hallett further says: 'From this selection I have now a pedigree barley which weighs fifty-seven and one-half pounds per bushel, raised upon land which was formerly declared unfit to raise barley suitable for malting.'

This is a matter of great importance to the farmer. If an increase in the weight of grain of as much as three pounds to the bushel can be obtained by sowing grain which has a pedigree, on account of proper selection, and if in addition to this he can obtain a grain of superior quality, it will make a very essential difference in the value of the product of an acre."

"The yield of corn is greatly reduced in many fields every season by the poor quality of seed that is planted. Seed that is immature, or that was injured during or after the curing process, was planted and much of it failed to germinate. After waiting several days for the sprouts to appear above ground, the farmer ascertains that the seed has rotted. It may not be too late to replant and obtain a good crop, but the chances are against it. The entire length of the growing season in the northern states is ordinarily required to produce a good crop of sound corn. If planting is delayed ten or twelve days after the usual time, the prospect is that the crop will be injured, if it is not entirely destroyed by an early frost.

If one is assured of a good crop from corn that is planted late, the trouble of cultivation is very greatly increased. When good seed is planted on land freshly prepared, it will come up quickly and keep in advance of the weeds. Cultivation will, of course, be necessary, but it may with safety be delayed till the young corn is sufficiently high to mark the rows. If it is necessary to replant, however, the weeds will be in possession of the soil, not only before the corn is up, but before it is planted. To have a clear field under such circumstances will require almost constant labor throughout the season. It is difficult to fight weeds that have obtained the start of cultivated crops.

In case part of the corn germinates and part does not, the situation is not much better. Considerable work is required to replant seed, and as it will not come up until the first planted has made considerable growth, extra work will be required in cultivating during the entire season. Whatever is the character of the season, the corn will not mature at the same time, and the

chances are that the portion last planted will not ripen before early frost occurs. It is the practice of some farmers to replant "missing hills" with some early variety, so that the two kinds may ripen at about the same time. Securing a uniform period of ripening, however, does not secure a uniform crop of corn. It will be a mixed lot which will rank low in the market.

The first essential success to corn raising is good seed. If a farmer has a good variety of corn, and it has attained a fair growth and become mature on the stalk, he can, by taking sufficient pains, secure reliable seed for planting. He should select the best ears for this purpose. He can make a much better selection when the stalks are standing on the hill where they grew than after they are cut up and put in shock. All but two or three husks should be removed from each ear, when they should be braided together and hung in some airy place to dry. An equally good plan consists in tying the ears in pairs and hanging them over a wire suspended in a chamber or some out-building, where they will be protected from the rain and snow.

If a farmer has not a first-class variety of corn, or has not raised a good crop on account of a bad season, deficient cultivation or poor soil, he should procure his seed from some person who has raised a superior crop. It is generally better to procure a supply in the fall than in the spring, as the price will be likely to be lower. No crop is more dependent on the quality of the seed than corn. In the case of small grains it is very difficult to select individual kernels to sow. It is comparatively easy, however, to select not only ears, but the kernels of corn for planting, as the amount of seed required for an acre is comparatively small."

The law of corn culture, upon which all successful corn raising depends, can be deduced from a brief study of the construction of a stalk of corn.

The common tree or shrub has a system of roots or rootlets co-extensive with its growth. If the growth is vigorous and

extensive with spreading boughs, we infer that the roots are in like manner deeply and widely distributed. But our general treatment of corn growth implies that roots are not essential to corn raising, because in its cultivation most farmers do not provide for the free and unrestricted growth of corn roots and fibres. The writer, has, during the past two years, made many careful experiments to ascertain the extent of the undergrowth or root system of the corn plant. These experiments were carried on by washing out the earth from the growing corn, leaving the roots and fibres exposed, except such filaments as had penetrated into the more solid ground beneath and beyond the reach of deep plowing. In every case of stalwart growth the roots had a range of 4 to 6 feet on each side of the main stalk and reached a depth of 24 and 36 inches. Within this space the branching and interlacing were so intricate and complete as not to leave a cubic inch of soil not penetrated by some of the corn root fibres. The corn roots of deep plowing as compared with the ordinary shallow plowing were estimated as 10 to 1 in extent, but the terms of comparison are difficult on account of the size and length of the roots; but the experiments were most convincing that the imperative need—the *sine qua non*, of successful corn culture in Nebraska is deep and thorough plowing.

The editor of *The Hastings Nebraskan* writes as follows:

"It is easy to say that every farmer who has cultivated his land well, and sowed his wheat deep, has the promise of a good crop. But there are a great many who did not sow deep, and have not a good crop. It has been a very costly lesson. We have been telling our farmers, for years, to sow and plant deep. But they have not heeded it—would not do it until thus taught by the rough lesson of a losing experience. In wet years it does not make so much difference. But deep seeding never does harm in this country; and, in a dry season, it is indispensable to a good, or even a fair crop. There will not hereafter be much broadcast seeding, except by green hands.

The benefits of deep sowing and planting are by no means

confined to the spring. Just before harvest the wheat usually ripens unexpectedly fast, in the midst of a spell of hot weather. In fact, it don't so much ripen, as dry up. The consequence is that the berry is not so plump and well filled. It does not weigh so much. Nor does it measure so much. It has simply dried out, because the roots were not down deep enough to resist the hot sun. Deep seeded wheat will resist this. The same is true of corn. In July we talk of 75 bushels to the acre. But, somehow, it don't fill out. The kernels neither become large nor plump, nor is the ear long or well filled-out. It is the same trouble. It dried out, cutting short the full growth, and leaving the result far short of what was expected.

In fact, there isn't the least danger of any one's sowing or planting too deep. Neither the drill nor the horse planter can be made to go deeper than is profitable and best. The grain consequently will not come up so quick, nor grow so fast as the first of the season; but it will more than make amends afterwards."

The common practice of corn culture proceeds upon the idea that length of furrow can compensate for depth of plowing. The average Western farmer, in his successful efforts to shirk labor, or to plan and contrive how not to do anything thoroughly, concentrates enough ingenuity and skill to make him rich if applied to his farm. Even with his neglect, Nature is propitious and yields him a living. Yet he rarely takes the hint she constantly suggests, and permits his land to yield him only a tenth of its ability.

Dr. Converse, of Lincoln, Neb., states that of 100 acres he plowed one-half nine inches deep and the other one-half seven inches, for corn. The harvest showed 20 per cent. in favor of the nine-inch plowing.

In an adjacent county a farmer cultivated 100 acres of corn as follows: First, a strip of 33 acres through the middle of the tract was plowed, twelve inches; the two outside strips were plowed only seven inches. During the growing period the

middle strip could be distinguished by the deeper color and greater growth, and at the close of the season the corn was two feet higher and yielded 33⅓ per cent. more than the two strips of shallow plowing.

It is quite time for our State Agricultural College to test the capacity of Nebraska soils with all kinds of crops and cereals, under various conditions, giving the definite results in statistics, with careful descriptions. These experiments, for a series of five years, leaving nothing undone that labor and skill can supply, would afford the most interesting page in the history of American agriculture. As it is now, Nature does nearly all; labor and skill being the lesser and least factors in farm products. It is a severe but just reflection on our agricultural colleges generally, that having the best facilities for farming, they give us no special or striking results; leaving to the public the practical inference that these institutions are sinecures, magnificently endowed by the general government, but manned by public pensioners, rather than able instructors. The public are obliged to render this judgment upon these colleges as long as the diligent farmer of the Western States, unaided, far exceeds the State Agricultural farm in the variety, value and profits of his annual crops.

The constant advice of our fathers was to plant groves and forests, if we desire to secure both permanent and increased rainfall. But I do not hesitate to say that every advantage obtained from groves in invoking the sweet influences of the rainy Hyades, or in producing rain, will be as well secured by the culture of corn.

A grove of thickly planted cottonwood of one hundred acres will bear exactly the same relations to the atmosphere as a field of corn of the same area. If now, we compare them with a forest of equal size, it will appear that the green coronal of leaves, although a hundred feet above the earth, has the same power upon the invisible moisture of the atmosphere as the same area of green grove or growing corn. In this manner we are

obliged to include, as of equal importance, every acre of the condensing surface of all growing crops.

The increase of corn producing territory in Nebraska, and generally in the Northwest, including great areas of increased altitude, depend upon a general law hitherto hardly noticed, but which is exemplified in the adaptation or acclimating of seeds. It is a great error to suppose that corn will grow and mature only at certain low ranges above sea level, or that there is a definite altitude limit to the growth of any of the cereals.

Our closet-philosophers and kid-gloved professors write voluminously of the West, in regard to their imaginary lines and limits of grain, grass or tree growth. But nature is far more lenient than their conceptions and dreams. According to their dogmas no corn could ever grow in Western Nebraska. Yet it does grow. Nor could corn ever be raised in Colorado. Yet it is annually raised in abundance.

Capt. Bridger, in 1847, offered Brigham Young $1,000 for an ear of corn raised in Great Salt Lake Valley. The first experiments were discouraging, but it was soon observed that corn planted from seed raised in the same locality, after a few trials yielded a profitable crop. Thousands of acres of corn in Utah in 1880 are proof sufficient that the range of corn growing will be almost without limit in the Northwestern States and Territories.

The State Agricultural Society of Nebraska should offer premiums for the encouragement of corn-culture, as follows:

$300 for the best 40 acres of corn yielding 100 bushels per acre.

$200 for the best 40 acres, 80 bushels per acre.

$100 for the best 40 acres, 60 bushels per acre.

Forty acres of corn yielding 50 bushels per acre, at 25 cents per bushel, gives a return of $12,50 per acre; but with average feeding it will return $25 per acre. The increased ratio of profit for 80 and 100 bushels per acre can be readily estimated.

It is currently estimated in the Western States, that corn is

worth 20 cents per bushel when hogs are worth 2 cts. per lb.; or 30 cents per bushel when hogs are worth 3 cts. per lb., and 40 cents per bushel when the swine market price is 4 cents per lb. As the average market for swine, by live weight, is rarely less than 4 cents, it should not require any argument to induce farmers to condense their corn crop by feeding to cattle and swine, because upon them is the least proportional tariff, or cost of transportation.

The Season of 1880.

Inasmuch as the dry season of 1880 has often been referred to as characteristic of Nebraska and Kansas, the following quotations from the monthly Report of the U. S. Commissioner of Agriculture for September, 1880, showing the corn prospect in the United States, may be referred to as evidence that the unusually dry term was universal:

Maine—"All crops shortened by drought;" "late crops injured by drought;" "driest season for forty years."

New Hampshire—"Crops suffered by drought."

Vermont—"Seriously affected by drought."

New York—"All crops seriously injured by drought;" "late crops suffered by drought."

New Jersey—"Late planted may have short ears by drought."

Peunsylvania—"Drought prevented earing well;" badly hurt by drought;" "half crop; drought;" "all crops suffered by drought."

Maryland—"Some injury by drought;" "materially shortened by drought;" "all crops seriously injured by drought."

Virginia—"Injured by drought;" "curtailed by drought."

Texas—"All late crops injured by drought;" "reduced by drought."

Arkansas—"Injured by drought."

Kentucky—"All crops cut short by drought;" "late planted almost a failure;" "all crops short; no rain for six weeks."

Ohio—"Three fourths crop by drought;" "shortened by drought;" "injured some by drought;" "late planted half crop; drought."

Michigan—" Considerably affected by drought."

Indiana—" Much injured by drought;" "smallest yield for twenty years;" "twenty-five per cent. short by drought;" "three-fourths crop, drought."

Illinois—" Greatly shortened by drought; cut short twenty-five per cent. by drought;" "half crop, drought;" "seriously injured by drought;" "much damaged by drouth and chinch bugs;" "reduced by August drought."

Wisconsin—" Injured by drought." "Damaged thirty per cent. by drought."

Iowa—" Reduced by drought;" "cut short by drought;" "retarded by dry weather;" "shortened twenty per cent. by drought."

Missouri—" Too dry;" "half crop, drought;" three-fourths crop, drought and chinch bugs;" "damaged fifty per cent., drought; thirty-five per cent. short of average; drought;" "no rain since July 15;" "failure on uplands."

CHAPTER XIV.

The Census of 1880 for Nebraska — With Notes on Immigration.

CENSUS OF NEBRASKA.

Population, 1855, 4,494; 1860, 28,841; 1870, 122,993; 1875, 246,280; 1880, 452,542. Abstract of census returns by Counties for 1880, as returned by the Federal enumerators to Hon. B. D. Slaughter and Hon. Bruno Tzschuck, U. S. supervisors of census for Nebraska, and reported by them officially as representing the population of this State for the year A. D. 1880, is as follows:

COUNTIES	POPULATION 1879	1880
Adams	8,162	10,239
Antelope	2,178	3,959
Boone	2,626	4,177
Buffalo	6,878	7,535
Burt	5,165	6,949
Butler	7,310	9,115
Cass	13,435	16,688
Cedar	2,775	2,898
Cheyenne	1,218	1,560
Chase*	.....	70
Clay	9,378	11,299
Colfax	5,960	6,604
Cuming	9,095	5,577
Custer	696	2,211
Dakota	3,208	3,216
Dawson	3,871	2,910
Dixon	4,061	4,177
Dodge	11,579	11,191
Douglas	36,557	37,870
Dundy*	.....	37
Fillmore	8,760	10,212
Franklin	4,137	5,465
Frontier	626	934
Furnas	2,982	6,406
Gage	9,629	13,170
Greeley	753	1,460
Gosper	622	1,674
Hall	6,375	8,562
Hamilton	6,478	8,277
Harlan	4,193	6,084
Hayes,* estimated	600	119
Hitchcock	264	1,012
Howard	3,246	4,410
Holt	1,839	3,231
Jefferson	6,280	8,123
Johnson	6,302	7,600
Kearney	2,840	4,075
Keith	274	191
Knox	2,088	3,664
Lancaster	18,675	28,097
Lincoln	2,017	3,679
Madison	4,280	5,587
Merrick	4,625	5,341
Nance	1,[illegible]00	1,208
Nemaha	10,504	1[illegible],458
Nuckolls	2,964	4,233
Otoe	13,863	15,736
Pawnee	5,899	6,924
Phelps	1,275	2,447
Pierce	684	1,215
Platte	7,587	9,554
Polk	5,023	6,855
Red Willow	963	3,044
Richardson	13,433	15,044
Saline	12,417	14,493
Sarpy	4,392	4,239
Saunders	13,528	15,827
Seward	9,382	11,095
Sherman	1,120	2,061
Stanton	1,486	1,813
Sioux*	.....	699
Thayer	4,535	6,129
Valley	1,540	2,334
Washington	8,361	8,650
Wayne	481	805
Webster	5,947	7,107
Wheeler,* estimated	700	644
York	9,112	11,171
Omaha and Winnebago Reservation		108
Unorganized Territory		2,916
Total	386,410	452,542

*Unorganized Counties.

None of the Western States or Territories have so rapidly or deservedly taken front rank in development, increase of population and wealth as Nebraska.

In 1855 its population was..	4,494	In 1877 its population was..	271,561
In 1860 " " " ..	28,481	In 1878 " " " ..	313,748
In 1870 " " " ..	122,993	In 1879 " " " ..	386,410
In 1876 " " " ..	257,747	In 1880 " " " ..	452,542

The ratio of increase with the States named since 1860 is thus stated:

	Per cent.		Per cent.
Nebraska	1,340	Iowa	208
Kansas	510	Wisconsin	171
Minnesota	394		

The ratio of increase in immigration since 1870 stands:

	Per cent.		Per cent.
Nebraska	310	Iowa	115
Kansas	176	Wisconsin	105
Minnesota	154		

In 1867, when admitted as a State, less than 300 miles of railroad were in operation; at the close of 1879 not less than 1,500, and this amount will be increased to 2,000 within two years in constructing already projected lines.

The general western movement of population has been referred to a certain law of emigration that compels humanity along the same parallels. Whatever the cause, the fact must be admitted. In our country the continuous flow of immigration is mainly within an area of 500 miles in width by 3,500 miles in length—from ocean to ocean along the 40th parallel. This belt, sometimes called the "Golden Belt" of our country, on account of grain culture, is more properly called the intelligence belt, because within its limits is found a large per cent of human progress. This favored region will be more accurately located by 200 miles south of the 40th parallel to 300 miles north of it. While the practical limits of this chapter do not permit an analysis of the social forces underlying the great western hegira

it is deeply instructive to read the passing comments of leading journals upon this absorbing subject.

From the Baltimore American:

"The history of the United States presents no parallel to the immensity of the number of immigrants who are now flocking to this country from all quarters of the world. Every day the records of the shipping lists of our dailies present the arrivals of not hundreds, as has usually been the case, but of thousands of immigrants, many of our steamships bringing each from 1,000 to 1,500. A very large proportion of this number is from Germany and the Scandinavian states; but probably the realms of Queen Victoria furnish a still larger number, for not only are they pouring in upon us by the Atlantic ports, but Canada and the other states of the 'Dominion' are at this time also furnishing an unusual number to add to the swelling tide from beyond the ocean. The estimate of the total number which will reach this country it may be difficult to determine, but we must doubt whether it will not attain to half a million during the present year. The continued unsettled state of the continent of Europe, and the probabilities of war between the leading nations contending for an aggrandizement of their territories, are inducing myriads of the subjects of these states to seek an asylum in this country, where so many of their countrymen have preceded them, and is beckoning them on with every demonstration which tends to display the happiness and success which are placed within their reach by a settlement in our midst, and the freedom from the liability of the draft in their own land to fill up the already enormous armies which their rulers are keeping up, and for the support of which they are obliged to toil in their native land.

While such is the case with the continent of Europe, Great Britain is furnishing us with her quota from other considerations, and that, too, of a different class from what in former years has occasioned an exodus to our shores. The revival of business prosperity in England, of which we had announcements, does not turn out to be permanent. Mr. Jennings, the London correspondent of the New York *World*, who ought to write intelligently, says that everywhere he hears the same story of continually declining trade and renewed disappointments. In Sheffield and Manchester there have been what proved to be mere "spurts" of renewed activity, while he doubts if the trade of London has been worse in this generation. The numerous co-operative stores, of which many of the well-to-do classes are managers and patrons, have played havoc with the retail dealers. There are new strikes in the mining districts. These facts partially explain the large emigration of the present year from that quarter.

But it is not principally from these classes of the manufacturing districts that the greatest number of immigrants may be expected, but from the increased disposition to emigrate from the tenant farmers—men with some amount of property, who yet feel that they are being crushed between the upper millstone of short leases and arbitrary landlords and the nether one of growing scarcity of tenant labor and increased rate of wages, superadded to the competition from this country, which, it is proved and acknowledged by the most intelligent minds, they cannot overcome. They are beginning to realize that though a season of bad crops, like that of 1879, may make their situation harder, they cannot obtain real relief unless by radical changes in the tenure of land, and these are not likely to come very soon. The farmers are conservative in their instincts, and are not likely to make a stampede. Still, when once a movement has begun, it is likely to gain strength. The capital which the great body of these tenant peasantry of Great Britain are obliged to have to enable them to effect a lease from the landlords would be amply sufficient in this country to obtain the fee simple of a farm, from which, in a very little time, with the skill and industry with which they are ordered by the necessities of their lives, they could be as independent as those to whom they and their forefathers have from time immemorial been paying rent and tithes and dues of various descriptions.

"And the question which should occur to every thinking mind is, Why is it that of the thousands of these immignants thus daily pouring upon our shores scarcely one in every thousand stops upon the soil upon which they are landed, but are in a few hours after arrival pushed off to a far distant Western State, where in most cases they are to encounter an inhospitable climate, and all the dangers, difficulties and diseases consequent upon a life such as is known they must be subjected to in a wilderness country? Are there no patriots in Maryland and Virginia to grasp this subject and take a lead in such measures as may be calculated to induce a portion, af least, of these strangers to settle in our midst? Or are we to be forever engrossed with the wranglings of sheer politicians, while our old and time-honored States are hastening to decay for the want of capital and well-directed labor to enable them to hold their own in the great race which is being forced upon them to maintain the position they formerly held in the production of newer branches of agriculture?"

From the London *Times*.

While the suitability of the New World as a nursery for our race is still a subject for speculation, the rapid multiplication of the citizens of the United States is an undoubted and noteworthy fact.

At the beginning of this century the population numbered a little over five millions and a quarter; at the census of 1870 it had risen to over thirty-eight millions and a quarter; in 1880 it is expected to reach forty-eight millions and a half. Though these figures are startling in their magnitude, yet they fall below what might have been expected had not a disturbing element intervened. According to the calculations of American statisticians, the great civil war caused the population in 1870 to be four millions less than the estimate based on the previous rate of increase. Since then immigration has slackened, so that the total decrease in 1880 from what might otherwise have been the number of inhabitants, is fixed by some authorities at nearly 10,000,000. In other words had it not been for this diminution a boastful orator on the 4th of July, 1880, might have been justified in announcing to admiring hearers that their fellow-countrymen numbered 55,000,000.

In reviewing the stages of progress it must be noted that, in the earlier days of the Republic, another cause than the natural rate of increase or the artificial aid of immigration contributed to add to its citizens. The extension of its boundaries—first, by the aquisition of Louisiana and Florida; second, by the annexation of Texas; and third, by the conquest of California—accounts for a considerable addition to the population. Even if the lowest and most moderate calculation of increase be verified, the accruing results will prove still vaster and more remarkable than those which we have set forth. Taking the rate of increase at 3 per cent. and applying it to the whole continent of North America, there will be 186,000,000 of people in the United States and the Dominion of Canada in 1925, representing a population of only one-seventh the density of that in England to-day. If we consider the entire American Continent, and its capacity for sustaining human beings, we are confronted with figures which resemble the extravagant calculations of an Oriental story-teller

The stupendous estimate has been made that 3,600,000,000 inhabitants might sustain life on the American Continent, and it is deemed not improbable that such may be the case four centuries hence. If this calculation were realized that continent would contain a mass of beings several times greater than the present estimated population of the globe. These are only possibilities, and, like other possibilities, they almost transcend human appreciation. Yet it is not till we understand the capabilities of the New World that we can comprehend the sanguine spirit of its people and the attractions it has for Europeans. The clearer our view of the prodigious opportunities for the emigrant to North America, the greater is our surprise at the apprehensions professed by many per-

sons in the United States lest their country should be overrun by immigration.

Whoever carefully examines the statistics showing how the population of the United States has grown of late years must be impressed with the rapidity with which the Western States are outstripping the Southern and Eastern. If Texas be classed among the Southern States, it may be regarded as an exception, because it seems to exhibit as rapid progress as any one in the West; yet, when its vast size is taken into account, there is nothing very wonderful in its development. Such States as Kansas and Illinois, Iowa, Nebraska and Minnesota, are really conspicuous in this rivalry, and they bid fair to continue to be distinguished above the others. It is with reference to these Western States that the words of Mr. Whittier, in his well-known verses on the Western pioneers, are fraught with perfect truth, for in them the pioneers are really advancing like the first low wash of waves where a human sea will soon break. The progress westward is the more significant because it is emphatically a progress of trained and seasoned men who have learned what life is in less congenial regions, and who are well adapted for bearing with equanimity and hardihood the privations inseparable from a new sphere of existence. The fertile prairies of the Great West are as inviting to the farmer who tills the stubborn soil of New England or Pennsylvania as the virgin land of the seaboard was to the first settlers in America.

Ex-President Hayes says:—The statistics of emigration, showing the movements of population which are going on in the world, afford a very good test of the comparative advantages and prosperity of the various civilized nations. People leave their own country and seek new homes in foreign lands to better their condition. Immigration into a country, therefore, is an evidence of that country's prosperity. It is also a most efficient cause of the progress of the country which receives it. During our civil war, and during the disturbed and troubled years, which immediately preceded and followed, immigration fell off and became of comparatively little importance, but now our country's prosperity, the stability of our government and the permanent prevalence of peace at home and with foreign nations, blessings which could not have been enjoyed by this country if the union arms had failed, have given to the world a confidence in the future welfare and greatness of the

United States which is pouring upon our shores such streams of immigration as were never known before. This is a fact of the most pregnant significance of our present condition. If we take a survey of the globe we shall find everywhere among civilized nations people looking forward for the time when they can emigrate to some more favored land. Only one of the great nations is in no danger of losing its capital, and labor and skill by emigration. We find only one which by emigration is gaining rapidly in number, wealth and power; all are losing by this cause except the United States. The United States alone is gaining. Other nations see their people going, going. We see from every quarter the people of other countries coming, coming, coming. There is one flag, and in all the world only one, whose protection good men and women being under it will never leave. There is one flag, and only one in the world, whose protecting folds good men and women, born under other flags that float under the whole heavens, are eagerly seeking. That flag so loved at home, so longed for by millions abroad, is the old flag under which we marched to save what in our soldier days we were fond of calling "God's country." It is that which chiefly attracts immigration. It goes where good land is cheap, where labor and capital find profitable employment, where peace and social order prevail and where civil and religious liberty are secured."

The East and West are changing places. In former days the West looked to the East for its wisdom and its funds. The position is not yet wholly reversed, but the signs are all in that direction. A Massachusetts correspondent of the Chicago *Standard*, after referring to the dying out of eight rural churches in his State, through the influence of emigration, says:

"It is time our Western friends had the facts in regard to New England. Our country churches are going, *have gone*, west. Our village churches the same. Our city churches in like manner. We have some vigorous churches and a limited number of wealthy merchants left, all of them within or near commercial or manufacturing centers. The population of New England, as a whole, *increases*, but that increase is wholly

due to the foreign elements, Irish, German, French, Canadians, Chinese, with a sprinkling of European nationalities other than those named. New England is one vast manufactory, with adjacent lands enough, barely enough, to grow milk, eggs and fresh vegetables. For the great staples of subsistence she is dependent on the West, and receives daily supplies regularly. In like manner will she soon be dependent on the West for spiritual supplies. Let it be told to the people everywhere, that the West must turn to and pay the East, in bulk, for the immense drafts she has made upon us, or we go to the wall in the great conflict of the future.

The writer has religious interests in view, but the picture he draws has a wider application. In many districts of the West there is more of old-fashioned American home life than is to be found in a corresponding number of New England localities, and in a generation or two the transformation will become still more general and complete.—*Cincinnati Gazette.*

From the *Omaha Herald:*

"If a volume could be gathered of all that has been written upon the west, it would doubtless be the largest volume in existence and its sheets would encircle the globe. At one time New York was west, and then Ohio and Indiana, and then Iowa, Minnesota and Wisconsin, and then came Kansas and Nebraska, and California, Nevada and Colorado. It has become a common word to say that there is no longer any west.

"But notwithstanding the removal of the old western land-marks there is still found a west of such magnitude that an empire could be located in its borders, so far as space is concerned. There is a country west of the Missouri, stretching to California, and from Mexico on the south to the British possessions on the north, that cannot be excelled in all the best requirements as the abode of men. This vast country is nearly one thousand miles square, besides allowing for the very sparse population of the new States and Territories within its borders. It has almost every variety of climate and soil, and produces everything from cotton in the south to the finest wheat in the extreme north, and fruits abound with all the necessaries and luxuries of life in the form of vegetation throughout this vast domain. The herds of buffalo, in millions, that formerly roamed over this vast territory, are rapidly becoming extinct, and millions of flocks and herds of native stock are taking their places, but the work is just begun. There is room for millions and millions more to fatten on

the grasses that now waste away annually—enough to feed the flocks and herds of the world.

"The mountains and the gulches, the river beds and the bluffs contain treasures of gold and silver and precious stones, and coal, and iron, and lead, and copper, and oil, indeed all the minerals in quantities that the most sanguine miner has not dreamed of, while the streams abound with the most delicious fish and the vast solitudes are alive with game of almost every description. There is one peculiarity in all this country—that it soon becomes self-supporting. The earth supplies all the wants of man. The richest mining points are surrounded with fertile soil enough to produce food for those who bring these mineral treasures from the bowels of the earth. And no part of this immense country is shut in from the highways of commerce. The Almighty in its formation, even among the mountains, has left the pathway for the coming millions, and the iron horse sweeps through the cañons, climbs the mountain sides, traverses the river courses and wakes the echoes with its puffing steam, starting the wild beasts from their lairs, and, while bringing supplies to the hardy pioneers, is scattering towns and cities all along its fiery pathway."

*In the ancient days, Fortune smiled upon those who went west. Abraham went west to the land of promise; yet Canaan, beyond Jordan, was far inferior to Nebraska. Columbus went west and found a new world. He set the fashion in modern times for our men of enterprise and daring. For nearly 400 years the east has given to the west her best men and women, her best treasures of brain and heart, her great inventions, her highest wit and wisdom. What a grand river of riches the east has for centuries poured into the mighty west; and yet the west is not full; but by this long and constant outpouring it has become the seat of Empire, far inland in the midst of the valley of the Mississippi. The center of population has marched steadily westward since 1790 at the rate of five miles per year, so that it will be found in the census of 1880 northwest of Cincinnati, on its way toward Nebraska. We should understand, therefore, that our western progress is in accordance with a law of humanity—a law controlling emigration, or the movements of men

*From an Address before the "Cambridge (N. Y.) Union," at Beatrice, Neb., Sept., 1879.

seeking homes or fortunes; in short, success; and if a law, it is Divine direction. Let no man boast of luck, or chance in the blessings he receives in the west, nor be discouraged at the adverse fates. The great movement of which he is a part has Providence for its mainspring.

If the farmers of Nebraska from a population of 400,000 can raise without extra effort 100,000,000 bushels of products, what may we expect when our population has reached 3,000,000? Two terms of this ratio are actual facts, and the conclusion is inevitable. With an area of 47,000 square miles, New York State has a population of 3,000,000 outside of her great city. At least 17,000 square miles of its area are occupied with mountains and wilderness, leaving only 30,000 square miles for use.

Nebraska has an available acreage equal to twice that of New York, or to the combined arable area of both New York and Pennsylvania. The statement just made by Senator Paddock that "Nebraska can take in the Empire State, and have room left for another of equal size," is strictly true.

A New York scion or sprout energized and fed on Nebraska soil will be a better and nobler product than its normal home growth. New England and New York are good nurseries but the common rule applies to them, viz: "Set out or transplant early." If in Nebraska we have clearer skies, purer water and richer soils than the East, what hinders us from being better in every way? Why should we have superior advantages if they are not to be reproduced in the superior excellence of our civilization? You may depend upon it as a grand principle that this extraordinary preparation in our soil, and this unequalled economy or system of subsoil, drainage, and climate are sure prophesies of a better grade of humanity. These graceful slopes and headlands that sweep away in lines of beauty from our streams and valleys—these majestic prairies that stretch "in airy undulations far away," these enchanting panoramas on every hand of river, grove and lawn, these golden harvests, these rich and inviting fields of enterprise, exist not merely for a race of exiles driven

hither by adverse winds. They are the natural and proper heritage for the sons and daughters of the best families of America.

Let your young men come here with the best endowment of of morals and education the East can bestow. At home, they can at best become clerks and subordinates, waiting for the frosts of age or a funeral to give them a position of trust or independence; but here, they become managers of affairs without delay. The great industries are in their hands to-day. Here they are bankers, treasurers, superintendents, merchants and farmers, at an age so early that they live double lives of usefulness. I can name hundreds of instances, but time forbids.

The question is often asked me, what is the most important discovery you have made in Nebraska? A similar question was once put to Sir Humphrey Davy. Said he, "The greatest discovery of my life was Faraday, when he was a little beggar boy in the streets of London." The most important of my discoveries in Nebraska is a quarter section of land. It is a museum of wonder and value; it is equal in value per acre to any acre in Washington County, N. Y.; Its surface was covered with fields of grain, whose market proceeds would more than pay for the land; and near the center was a spring and a grove which encircled a happy home filled with many tokens of prosperity and the merry music of children. Half concealed from view were barns, pens, coops, granary, shed for wagons, plows and machinery, all in good order, while farther away and central in a grass plat shaded by two friendly elms was a white school house. In the distance it looked like a pearl in an emerald setting. "Will you take $30 per acre for your farm?" said I; "Why should I sell it," he replied; "it is my home, we are healthy, prosperous and happy." There was that sense of strength and security around this new home which gives that equipoise to mind and body so essential to spiritual and mental culture. It was natural to think of the hard lot of many thousands in the East who could easily with the same limited means conquer and possess a home like this; and there can be no higher mission, or

nobler errand, than for you whom we greet here to-day from your homes beyond the Hudson river, to return and assure the thousands who will receive your report, of the ways of pleasantness, of the paths of success, and the opportunities for homes and farms in Nebraska. How many such homes as above described one could actually find to-day in Nebraska, we may not determine; but we are certain that there are one hundred thousand just such golden opportunities. This number would require only sixteen millions of acres, while our unimproved domain of good farming land far exceeds that amount.

A recent examination (1878) of the Great Republican Valley in Nebraska has proved to me the accuracy of this statement. When we had reached the 100th meridian we had every reason to see the great desert, so recently described in the state papers made and published in Washington; but instead, on that identical meridian, and intersected by it, were tens of thousands of acres of grain of all kinds, equal to any raised in eastern New York in 1878. In our camp we reviewed the description of the region given by our public desert makers. It was amusing to read in their own words, their desert talk, in the midst of the most bounteous harvest; but it seemed all the while as if some one had deliberately and repeatedly lied! We continued our search for the Great American Desert with lessening faith in our civil service. There was no diminution in crops towards the western limit of the State. The frontier farm of eighty acres is fifty miles beyond the 100th meridian, and is a model of good farming. There it lies, open to the heavenly blessings of rain and sunshine, bearing witness in the distant wilderness that every acre of the millions of acres surrounding it is equally capable of being a farm or a garden. These fields of corn, like platoons of soldiers in green uniforms, are like an army of deliverance setting the land free from the desert character attributed to it; and those rich yellow squares of ripened wheat, oats, rye, and barley, are suggestive of mines of gold where every farmer can be a rich miner in a few years.

COMPARATIVE STATISTICS FOR 1860, 1870, 1880, OF THE POPULATION OF THE UNITED STATES AND TERRITORIES.

STATES.	1880	1870	1860
Alabama	1,262,344	996.992	964,[illegible]01
Arkansas	802,564	484,471	435,[illegible]50
California	864 686	560 247	379 [illegible]94
Colorado	194 649	39,864	34,277
Connecticut	622 683	537,454	46[illegible],147
Delaware	146,654	125,015	112,216
Florida	266 566	187,748	140,4[illegible]4
Georgia	1 538,983	1 184.109	1,057.286
Illinois	3 078 636	2.539,891	1,711.951
Indiana	1 978.358	1,194 020	1,350.428
Iowa	1 624 463	1,194,020	674.913
Kansas	995.335	364,399	107.2[illegible]6
Kentucky	1,648.599	1 321.011	1,155.[illegible]84
Louisiana	940,263	726 915	708 [illegible]2
Maine	648 945	626 915	628.279
Maryland	935,139	780,894	687.049
Massachusetts	1,783,086	1.457 351	1,23[illegible] 066
Michigan	1 634,096	1,184,059	749.[illegible]13
Minnesota	780 807	439,7[illegible]6	172.[illegible]23
Mississippi	1 131.899	827,922	971 305
Missouri	2 169.091	1 721.295	1,18[illegible], 12
Nebraska	452,542	122,993	28.841
Nevada	62 265	42 491	6,857
New Hampshire	347.784	318,300	326.[illegible]73
New Jersey	1,130 892	906,096	672 035
New York	5,083.173	4 382.759	3,88[illegible].735
North Carolina	1,400,000	1,071.361	992 [illegible]22
Ohio	3,197 794	2,665,260	2,339 511
Oregon	174 767	90,923	52 [illegible]
Pennsylvania	4,282,738	3,521 951	2,906 [illegible]15
Rhode Island	276.528	217,393	174 [illegible]
South Carolina	995,706	705,606	70[illegible]
Tennessee	1 542 463	1,258 520	1,109 [illegible]1
Texas	1 597 509	818.579	604 [illegible]
Vermont	332.286	330 551	315 [illegible]9
Virginia	1 512 203	1,225,163	1,596.[illegible]18
West Virginia	618.193	442,014	.....
Wisconsin	1 315,386	1 054,670	775,[illegible]1
Total	49,369,965	38 155,505	31,218 [illegible]1
TERRITORIES.			
Alaska	....	....	....
Arizona	40 441	9 658	....
Dakota	134 502	14,181	4 837
District of Columbia	177 638	131,700	75 070
Idaho	32 611	14 999	....
Montana	39.157	20 595	....
New Mexico	118 430	91 874	93 516
Utah	143,907	86,786	40 273
Washington	75.120	23,955	11 594
Wyoming	20.788	9,118	....
Total	782 584	402,866	325 000
Total United States	50 152.554	38.558,371	31,443,321

Political Status of Nebraska.

COUNTIES.	1880. Rep. Garfield.	1880. Dem. Hancock.	1880. Greenb'k Weaver.	1876. Rep. Hayes.	1876. Dem. Tilden.
Adams	1,447	550	51	767	204
Antelope	577	145	88	206	65
Boone	671	226	....	262	65
Buffalo	1,195	390	38	491	160
Burt	1,010	380	47	674	310
Butler	958	716	114	583	418
Cass	1,861	1,303	196	1,367	901
Cedar	218	326	....	144	287
Cheyenne	232	322	....	103	200
Clay	1,517	520	59	1,037	341
Colfax	685	399	2	465	458
Cuming	598	537	57	408	496
Custer	299	130	....	.....	.....
Dakota	328	386	....	.....	.....
Dawson	347	179	....	171	76
Dixon	459	315	6	363	294
Dodge	1,459	1,079	2	984	956
Douglas	3,290	2,407	192	2,342	2,270
Fillmore	1,404	452	160	839	261
Franklin	585	248	56	357	157
Frontier	133	42	....	.....	.....
Furnas	606	201	54	201	64
Gage	1,726	789	199	847	242
Greeley	182	127	6	38	3
Gosper	156	70	11	23	9
Hall	1,150	547	14	720	295
Hamilton	997	346	301	637	31
Harlan	678	289	33	342	115
Hitchcock	135	49	....	16	10
Holt	334	309	75	22	13
Howard	637	352	3	202	84
Jefferson	1,069	401	183	581	187
Johnson	1,068	579	2	697	376
Kearney	550	242	6	186	42
Keith	32	51	....	16	55
Knox	556	230	16	216	50
Lancaster	3,397	1,881	110	1,951	711
Lincoln	377	264	....	[illegible]51	289
Madison	670	426	58	366	299
Merrick	819	275	34	564	205
Nance	199	84	....	.....	.....
Nemaha	1,473	857	8	1,087	603
Nuckols	594	331	6	213	94
Otoe	1,918	1,226	49	1,256	1,087
Pawnee	1,181	326	82	731	165
Phelps	426	36	31	61	8
Pierce	76	119	....	20	101
Platte	854	832	12	514	530
Polk	943	236	11	548	79
Red Willow	283	147	48	82	20
Richardson	1,764	1,492	133	1,264	1,076
Saline	1,811	997	106	1,053	469
Sarpy	491	516	19	391	421
Saunders	1,717	556	697	1,106	464
Seward	1,354	699	226	905	325
Sherman	308	80	9	61	39
Stanton	180	160	14	126	131
Thayer	884	348	62	398	123
Valley	392	93	....	182	6
Washington	1,180	499	31	977	462
Wayne	118	43	....	49	12

Nebraska, most central in the American Republic, has an area of **76,000** square miles, or **48,640,000** acres, of which **45,000,000** acres, according to recent surveys, are capable of farm cultivation. It has **20,000** square miles more than Iowa, **12,359** square miles more than all the New England States, and only **4,000** square miles less than twice the size of Ohio. Its entire surface, soil and subsoil is the loess formation—the richest in the world. Its population in 1855 was **4,500; in** 1856, **10,716;** in 1875, **246,280;** in 1878, **386,000;** in 1879, **420,000;** in 1880, **452,542**—a greater ratio of increase than any other State can exhibit. Nebraska has now nearly **7** inhabitants per square mile—Kansas has **11.** It can support **75** per square mile, or **100**, or **230** as well as Ohio, New York or Massachusetts. With **75** as in Ohio, its population will be over five and a half millions. Its ratio of increase of taxable property is as follows: In 1868 ,**$32,632,500;** in 1869, **$42,123,595;** in 1870, **$53,709,828;** in 1872, **$69,873,818;** in 1873, **$78,239,692;** in 1874, **$80,754,044;** in 1879, **$75,359,798;** in 1880, **$90,000,000.**

The average valuation of land in Illinois is **$25** per acre; in Ohio **$30** per acre; in Nebraska only two dollars, but by the law of increasing real estate values, the lands of Nebraska are certain to reach **$20** per acre, or a total valuation of **$1,000,000,000.** Saline county, for instance, has increased from **$487,845** in 1870, to **$2,741,932** in 1880; or from less than one to over seven dollars per acre.

Nebraska has **80,000** acres of cultivated timber, bearing of all varieties **38 000,000** trees; besides **1,273,000** apple trees, **1,250,000** peach trees, **36,000** pear trees, **145,000** plum trees, **217,000** cherry trees, **208,000** grape vines, and **15,000** miles of hedge.

The fruitage of 1877 was: Apples,**90,570** bushels; peaches, **17,876** bushels; cherries, **681** bushels; grapes, **260,000** pounds; 50 per cent. may be added for the present time.

The grain product of 1874 was **10,000,000** bushels; in 1879, **100,000,000** bushels. The swine crop of 1878, **295,000** head; of 1879, **700,000**; cattle, **260,000** and **200,000** sheep.

Prairie lands at **2, 3, 5, 7** and **10** dollars per acre, according to locality, have an annual increase in value of from **15** to **20** per cent. Improved lands at **7, 9, 10, 12** and **15** dollars per acre, are advancing from **20** to **25** per cent. annually. Railroad lands, offered at low prices on long time, compel low average land sales. When these lands are disposed of there will be a general advance in values to the general level of real est te in Illinois, Ohio and Michigan.

A rise of **$5** per acre is an extra cost of **$800** to the new comer for a quarter section.

Nebraska contains **3,132** school districts with new school houses, and **175,000** pupils. It has **80,000** farmers whose families and dependents exceed **575,000** persons. Its common school basis is **2,443,143** acres of land held at **$7** per acre, yielding as the years go on a fund of over **$18,000,000.** It has also a bountiful University endowment of **45,119** acres, and **89,452** acres of Agricultural College lands. Over **22,000,000** acres of lands are now subject to pre-emption, homesteads and timber claims within the limits of Nebraska. It has **1,200** miles of railway in actual operation, **420** miles being constructed, and **350** miles quite certain to be built—in all **2,000** miles in 1880—making an extra taxable basis of **$15,000,000.** The business of Nebraska employs a capital of **$20,000,000.**

The average rainfall in Eastern Nebraska is **33** inches per year, in Middle Nebraska **26** inches, and in Western Nebraska **17** inches, with an average increase for year periods sufficient for all farm products after the ground is prepared. Roads are perfect throughout the year. Average winter **17°** F., average summer **72°** F. Climate of unequalled salubrity. Water pure and plenty. Timber enough for ordinary fuel in nearly all portions of the State—ratio of increase, to use **4:1**. It contains **10,000** beautiful valleys, with innumerable springs and clear water streams. It is indeed "a land of brooks and water, of fountains and depths that spring out of valleys and hills; a land of wheat and barley, and vines and fig trees and pomegranites; a land of oil, olives and honey; a land wherein thou shalt eat bread without scarceness, thou shalt not lack anything in it."

Nebraska leads all the States in every ratio of increase; in every comparative test of productive ability and in all inducements that determine the choice of people seeking new farms, new business and new homes in the new empire of the Northwest.

CHAPTER XV

Lands and Land Laws — Public Surveys — Government Lands — State and School Lands — Railroad Lands — Land Entries — Homestead, Pre-Emption and Timber Claims — Nebraska Tax Laws and regulations.

THE present system of U. S. public land surveys is attributed to Gen. Wm. H. Harrison as its inventor. Previous to its adoption, lands were described by metes and bounds, or arbitrary lines and angles. Starting from a tree or stone, or some movable or perishable land mark, farm boundaries were often in dispute. By the system now in use we are able to definitely locate upon a map any tract of land, large or small, in any surveyed part of the Western States and Territories.

The theory of new system pre-supposes the establishment of infallible base lines and meridians, to which constant reference can be made.

Meridian lines were first established running due north from the mouth of some important river. These are intersected with base lines. There are six principal meridians in the land surveys in the West. The first principal meridian is in a line due north from the mouth of the Miami river, in the State of Ohio. The second principal meridian is in a line due north from the mouth of the Little Blue river in Indiana. The third principal meridian is in a line due north from the mouth of the Ohio river, at Cairo, Illinois. The fourth principal meridian is in a line due north from the mouth of the Illinois. The fifth principal meridian is in a line due north from the mouth of the Arkansas river. Each of these meridians has its own base line.

The surveys connected with the third and fourth meridians, and a portion of the second, embrace the State of Illinois. The base line for the second and third commences at Diamond Island, in the Ohio, and run due west to the Mississippi.

The third principal meridian terminates at the north boundary of the State. The fourth principal meridian commences in the center of the channel, and at the mouth of the Illinois, but immediately crosses to the east shore and passes up on that side to a point in the channel of the river seventy-two miles from its mouth. Then its base line commences and extends west to the Mississippi.

The fourth meridian is continued north to a curve in the Mississippi; it here crosses and passes up on the west side fifty-eight miles, recrosses into Illinois, and passes through the town of Galena, to the north boundary of the State. It thence continues to the Wisconsin river, being the meridian for the surveys of the territory, while the north boundary of the State constitutes the base line.

In numbering the townships, east or west from a given meridian, they are called Ranges, but in numbering north or south from a base line they are called Townships.

Townships are subdivided into square miles, or tracts of 640 acres, each calld sec tions.

Upon the sixth principal meridian, with its base line the fortieth parallel of latitude, is arranged the system of surveys for public lands in Nebraska and Kansas. This meridian crosses the fortieth parallel between Gage and Jefferson counties, and also is the dividing line between Saline and Fillmore counties, having as a starting point the intersection of the base line and principal meridian.

1st. Standard parallels are run, at intervals of twenty-four miles or the with of four townships, on the north of the base line and at an interval of thirty miles, or five townships on the south of the base line.

2nd. Guide meridians are next established at distances of eight townships or forty-eight miles east and west of the principal meridian.

In this manner large parallelograms, 24 and 48 miles, are formed, whose limits are the base line, principal meridian stand-

ard parallel and guide meridian. These paralellograms are the basis of the land survey.

Each of the larger areas, twenty-four by forty-eight miles, is divided into townships six miles square, or 23,040 acres, and each township is subdivided into thirty–six squares called sections, each containing 640 acres.

3rd. Sections containing each one square mile are the units of the survey, and are numbered from right to left to the sixth section; from left to right from the seventh to the twelth section; from right to left from the thirteenth to fhe eighteenth, and so on, giving the numbers one, six, thirty-one and thirty-six as four corner sections of a township.

A CONGRESSIONAL TOWNSHIP.

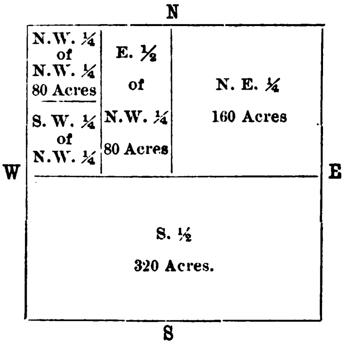
N

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

W — E

S

A. SECTION.



In their application to present needs, the laws, regulations and decisions pertaining to homestead, pre-emption and timber culture entries are most important.

"On the first of January, 1863, the Homestead Law went into operation. The subject of granting free homesteads upon the public lands to actual settlers, had long been agitated, through the public press and by means of organizations effected for the object, and intended to influence legislation. The land reform had repeated and insisted on the truth of the declaration that Land, Air and Water were intended by the Creator to be

alike free to all men. At length the sentiment took the form of legislation—so far as a distribution of the public land is concerned—and now the government and the people have had seventeen years of experience under the operation of the homestead law.

That the government is satisfied, and that no detriment has resulted to its revenues from this change in the mode of disposal of the public domain, is shown by the declaration made by the commissioner of the general land office in his report, that "the demand for the benefit of the homestead laws still increases, with results showing the wisdom of the law, as a measure for quickening and expansion of the productive area and material wealth of the country, by offering lands for homes at a nominal cost, to the hardy pioneers of our American civilization.

Congress, in order that the benefits of the law might be distributed justly, has, from time to time, amended its provisions and enlarged its scope. In particular, new and most liberal provisions have been made, by which the soldier, his widow and his orphans, are permitted to receive enlarged privileges in securing homesteads, thus adding to the national recognition of the principal that every citizen of the republic is entitled to the right to make himself a home upon the public domain, the still nobler and higher doctrine that it is the nation's duty to reward the defenders of the country, and to provide homes for the families of those who gave up their lives in its defense.

The Congress of 1873 passed three separate acts enlarging the homestead privilege; one of which, containing provisions for the encouragement of timber cultivation, is calculated not only to shorten the time within which the settler may obtain a patent for his land, but also to greatly stimulate one of the most useful branches of cultivation.

The public surveys have, from year to year, been extended to meet the wants of the emigrant as he has pushed his explorations toward the frontier. And as the surveyor has gone forward with his compass and chain, followed closely by the im-

migrant, both have been surprised with the beauty and richness of the country, and both have looked in vain for their western limit."

The public lands of Nebraska are classed as agricultural lands, and may be taken under either the pre-emption, homestead or timber culture laws.

FIRST—PRE-EMPTION.

Every person who is the head of a family, or over twenty-one years and a citizen of the United States, or has declared his intention to become such, who does not own 320 acres of land in any State or Territory, is entitled to enter a quarter section of land under the pre-emption act, but no person can move off from his or her own land in the State of Nebraska upon a tract of land, and enter it under the pre-emption act. The rules of the General Land Office require a person to build a house and break at least ten acres of land before he can make proof and get a title to the land.

In order to take a pre-emption a settlement must first be made on the tract. This may be by any act that will show that labor has been done, such as breaking a piece of ground, staking out the foundation for a house, or by other act of labor that will give notice of occupancy. A reasonable time is given from the date of settlement in which to build a house and make a residence thereon. No definite time could be fixed upon, because a reasonable time in which to build a large house might be an unreasonable time to build a small one—or a person with ample means could reasonably build quicker than another without means.

The government lands in the State of Nebraska are "unoffered;" that is they have never been offered at public sale by a proclamation of the President of the United States. On this class of lands ninety days are given from the date of settlement in which to file a declaratory statement, which is simply a notice that the pre-emptor intends to take the land, and thirty-three

months from the date of settlemet in which to make proof and receive a title; but, as said before, proof may be made after six months provided a house has been built, and the pre-empting party has resided and is residing there at the date of proof, and has broken at least ten acres of land.

HOMESTEADS.

Any person who is over the age of twenty-one years or is the head of a family and is a citizen of the United States, or has declared his intention to become such, under the laws thereof may take a homestead. He is required to subscribe to an oath that he takes it for his own especial benefit and not directly or indirectly for the use or benefit of any other person or persons, and that he has not had the benefit of the homestead act heretofore, together with the fact that he is the head of a family or over the age of twenty-one years, and that he is a citizen of the United States, or has declared his intention to become such.

He is required to commence his residence thereon within six months, and to continue until five years from the date of his entry, at which time he will, upon proof of residence and cultivation, receive a patent therefor. No specific amount of land is required to be cultivated, but it is generally held that in order to show good faith, at least ten acres should be broken and cultivated, but if a good reason can be shown why it has not been done the lack of cultivation will not be fatal to the proof. The law further provides that the party cannot be absent from the claim for a period of six months, at any one time, regardless of excuse, Two years from the expiration of the five years is given the party to make said proof, and if at the expiration of said time, upon notice being given him from the local office, he does not, within thirty days of the date of said notice, furnish the required proof, his entry shall be cancelled and has again become subject to entry. If a party taking a homestead does not comlpy with the law his entry may be contested. The contesting party alleges in an affidavit that the homesteading party has not complied with the law, and asks for a hearing. Notice is given

the adverse party, and, if the facts alleged are proven, the entry is cancelled by the commissioner of the general land office, and the tract is again open to entry.

A Soldier's Homestead

provides for persons who served in the late rebellion. The time served in the army is credited as a part of the five years required to be spent upon the homestead, provided that the homesteader must reside one year on the tract homesteaded.

It also provides that a soldier may file a homestead declaratory statement on a tract of land, which holds it as against any subsequent claimant for six months, but the party filing said declaratory statement must within six months appear and file his application and affidavit, and at the same time establish the fact that he was a soldier in the late rebellion. This may be done with a copy of his discharge, a certificate of the Adjutant General of the State in which he enlisted, or the affidavit of three disinterested witnesses stating the date of his enlistment, date of his discharge and the company and regiment in which he served.

He must also establish the fact that he served in the army before he is allowed to file his homestead declaration.

A homestead declaration is the only filing that can be made by power of attorney. If, for any reason, the party filing a homestead declaration desires to take another or different tract of land he may do so, instead of taking the tract upon which he filed his homestead declaration, but he can not file but one homestead declaratory statement. The land office fees for filing a homestead declaratory statement is two dollars.

Final proof on a soldier's homestead may be made at any time after the time resided upon the homestead, together with the time served in the army, makes five years, provided one year's residence has been made upon the land, or at any time thereafter within seven years from the date of the application for the homestead.

If the soldier be dead his widow may take it in his stead and it does not deprive her of the privilege, if she has taken one before in her own name, and if she is dead or has married again it may be taken by his minor orphan children. If taken by the widow, the same requirement of residence and cultivation is made as would have been made of the soldier, if living; but in the case of minor orphan children, the entry is made for them by their guardian duly appointed, and in that event cultivation only is required.

The land office fees for initiating a homestead are for minimum land, that is, land that is sold by the government at $1.25 an acre, $14 for a quarter section, or $7 for 80 acres, and in double minimum, or land that is sold at $2.50 per acre, $18 for a quarter section, which sum is required at the time the claim is taken, and upon making final proof a further fee of $4.00 for a quarter section, or $2 for 80 acres, on minimum lands; and $8 for a quarter section, or $4 for 80 acres, on double minimum lands.

Timber Claims.

Only one timber culture entry can be taken on each section. This class of entries can only be taken upon "prairie land, or land naturally devoid of timber."

A person competent to take a homestead entry is also competent to take a timber culture entry, and the same facts are required to be sworn to in the affidavit accompanying the application. The law requires that five acres be broken within the first year; that it be cultivated the second year, and planted to forest trees, or planted with the seeds of forest trees, four feet apart each way, within the third year; and that a second five acres be broken the second year, cultivated the third year, and planted as in the first instance the fourth year, and that if the ten acres be kept in a growing condition a patent shall issue for the tract at the expiration of eight years, provided not less than six hundred and seventy-five trees be found in a growing condition at the expiration of that time.

The fees of the government are the same in timber culture entries as they are in homestead entries except that there is no distinction made between minimum and double minimum lands.

Timber culture entries are contested for non-compliance with the law the same as homesteads, but in timber culture contests the contestant may file his application for the land with the affidavit of contest, and in this manner make it absolutely safe for himself; whereas in homesteads he can only make it safe by dilligence in his appearance at the land office upon the receipt of the notice of its cancellation at the local land office from the general land office.

Special Instructions From the General Land Office.

To Registers and Receivers:

Gentlemen—you are hereby instructed to deliver to each applicant for land under the homestead, prsemption, or timber culture acts, and before an entry or filing is permitted, a copy of this circular especially calling his or her attention to the requirements of the law under which the application is made, and to that portion of the circular relating to second entries. After an entry has once been made, if the same was legal and the land was subject to entry at the time, the party has exhausted his right under the law, and cannot abandon or relinquish the same and make a second entry. Therefore it has been your practice after an entry or declaratory statement has been permitted, to allow the party making the same to relinquish the tract and substitute other lands therefor, at any time prior to the expiration of the month during which the entry or filing was made, you are informed that such practioe must not be continued, except in case of clear illegality or mistake. A party should not be allowed to hold a tract, even for a limited number of days, by a conditional or partly perfected entry. All applicants must stand upon equal footing, with equal rights and privileges to enter the public lands.

The applicant is required to establish his or her actual residence in a house upon the land within six months from the date of entry, and must reside upon the land continuously. If the applicant is a single person, the actual residence upon the land must be the same, and this must be continuous during the period of time required by law, viz: Five years, unless the settler is entitled to credit for military service during the war of the rebellion. A Union soldier in that war is entitled to deduct from

the five year's residence the time he was in service, not to exceed four years. In other words, each soldier or soldier's widow must reside upon the land at least one year before he or she can make final proof. In case of the death of the soldier, his widow, if unmarried, will be entitled to all the privileges of the soldier. In case of the death or marriage of the widow, the minor children of the soldier, by a guardian duly appointed and officially accredited at the Department of the Interior, may be entitled to all the privileges to which the father would have been entitled. In such cases, however, neither the guardian nor the minor children are required to reside upon the land entered, but the same must be cultivated and improved for the period of time during which the father would have been required to reside upon the tract. Soldiers may upon the payment of a land office fee of $2.00, or $3.60 in certain States and Territories mentioned below, file a soldier's declaratory statement upon a tract of land, and thereby obtain a preference right to enter said tract at any time for a period of six months, but before the expiration of six months the entry must be made in due form, or said preference right to enter will be lost. The declaratory statement may be filed by an attorney in fact. After entry the settler must reside upon, improve and cultivate his land, and in all respects show his good faith. An occasional visit to the land every few weeks or months, and the occupation of the same by a tenant, and the improvement of the tract, is not a compliance with the law, and the entry is subject to cancellation. In all cases the actual home and residence of the claimant must be upon the tract entered. An occasional necessary absence for a few days, or even weeks, will not subject the claim to forfeiture, if the settler shows his or her good faith in all respects.

Under the homestead law the applicant must appear in person at the local land office, present his application and take the required oath. The final affidavit and proof, however, may be made before the judge, or, in his absence, before the clerk of any court of record of the county and State, or district and Territory, in which the land is situated; and if said land is situated in any unorganized county, such proof may be made in an adjacent county.

If a settler is prevented, by reason of distance, bodily infirmity, or other good cause, from personal attendance at the district land office, it may be lawful for him to make the affidavit required by law before the clerk of the court for the county in which the applicant is an actual resident, and to transmit the same, with the fee and commission, to the register and receiver. In such cases the affidavit must state that the party, or some member of his family, is residing upon the land, and that a *bona*

fide settlement and improvement has been made thereon; it must also state the cause of the inability of the applicant to appear at the local land office. In such case the applicant should understand that the clerk of the court is, in no sense, an officer of the land department. The applicant attains no rights whatever until the application is presented at the local land office, accompanied by the affidavit and the fees and commission.

A homestead settler may, after an actual residence of six months and cultivation and improvement of the land, make proof and payment for the same, and this action will not affect his rights as pre-emptor, except that he cannot move from said tract and settle upon other public land in the same State or Territory and claim the same under the pre-emption law.

THE PRE-EMPTION LAW.

A claimant under this law for land which has been offered is required to file a notice of his or her claim within thirty days from date of settlement. If the land has not been offered for sale, the declaratory statement must be filed within three months from date of settlement. If the land is not surveyed at date of settlement, the declaratory statement must be filed within three months from date of filing the township plat in the local office. A failure to file a declaratory statement will render the land subject to the claim of an adverse settler who does thus file notice of intention required by law to claim the land.

The land office fee for filing is $2, except in certain States and Territories mentioned below, in which it is $3. If the land is offered, proof and payment for the same must be made within twelve months from date of settlement. If not offered, said proof and payment must be made within thirty-three months from the date of settlement. A failure to thus make proof and payment will render the land subject to the claim of an adverse settler who does comply with the law in the matter of filing a declaratory statement and making proof and payment.

The same requirements as to residence and cultivation and improvement must be observed under this law as under the homestead law; that is, the claimant must actually reside upon and make his home upon the land. An impression may prevail in the minds of settlers that because the courts and the department have held that a person cannot, under the homestead and pre-emption laws, take land in the possession of another, and improved and cultivated by him, a settler may be released and excused from a compliance with the law in the matter of residence. Such, however, is not the fact. Upon the showing of a failure to comply with the law on the part of the claimant in this respect, the entry or filing will be can-

celled, and the land, restored to the mass of the public domain, will be subject to disposal under the laws of the United States. If a settler fails to comply with the law his claim will be forfeited. The right of a party to take the land improved by and in the possession of another, will be a question considered upon its merits. Good faith must also be shown by the settler in the matter of improvements and cultivation of the land. Proof and payment may be made at any time after six months of actual residence and improvement of the tract. The improvements must be of a substantial and valuable character. The settler must appear in person at the land office and give his own testimony. The evidence of his witnesses may be taken before any officer authorized to administer oaths under State or Territorial laws in cases where such witnesses live at a great distance from the land office. Blanks for this purpose will be furnished by application to any land office.

Timber Claims.

Any party making a timber claim entry of 160 acres is required to break five acres of them one year from the date of entry. The following or second year said five acres must be actually cultivated to crop. The third year the first five acres must be planted in timber, seeds, or cuttings, making, at the end of the fourth year, ten acres thus planted. Perfect good faith must be shown at all times by claimants. The timber must not only be planted, but must each year be protected and cultivated in such a manner as to promote its growth. A patent may be obtained for the land at the expiration of eight years from date of entry, upon showing that for said eight years the trees have been planted, protected, and cultivated as aforesaid, and that not less than 2 700 trees were planted on each acre, and at the time of making proof there shall be then growing at least 665 living trees to each acre. If at any time during the said eight years it shall be shown that the party has failed to comply with the terms of the law, the entry will be cancelled. Under this law, good faith will require that if the trees, seeds, or cuttings are by any means destroyed one year, they must be replanted the next. A party will not be released from a continued attempt to promote the actual growth of timber or forest trees; a failure in this respect will subject the entry to cancellation. Only the plant-

ing of such trees, seeds, or cuttings as are properly denominated timber trees, or which are recognized as forest trees, will be considered a compliance with the law. Cottonwood is recognized as timber under the act. "All entries of less than one-quarter section shall be plowed, planted, cultivated, and planted to trees, tree seeds, or cuttings in the same manner and in the proportion hereinbefore provided for" in the 160 acre entry. The land office fee for an entry of more than 80 acres is $14; for one of 80 acres or less, $9.

The law provides that in case the trees, seeds or cuttings shall be destroyed by grasshoppers, or by extreme and unusual drouth, for any year or term of years, the time for planting such trees, seeds, or cuttings shall be extended one year for every such year that they are so destroyed.

Very respectfully,

J. M. ARMSTRONG, Act'g Com.

Approved: C. SCHURZ, Sec'y.

Department of the Interior, March 12th, 1880.

AN ACT FOR THE RELIEF OF SETTLERS ON PUBLIC LANDS.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That when a pre-emption, homestead, or timber-culture claimant shall file a written relinquishment of his claim in the local land office, the land covered by such claim shall be held as open to settlement and entry without further action on the part of the commissioner of the general land office.

SEC. 2. In all cases where any person has contested, paid the land office fees, procured the cancellation of any pre-emption, homestead, or timber-culture entry, he shall be notified by the register of the land office of the district in which such land is situated of such cancellation, and shall be allowed thirty days from date of such notice to enter said lands; *Provided*, That said register shall be entitled to a fee of $1 for the giving of such notice, to be paid by the contestant, and not to be reported.

SEC. 3. That any settler who has settled, or who shall hereafter settle, on any public lands of the United States, whether surveyed or unsurveyed, with the intention of claiming the same under the homestead laws, shall be allowed the same time to file his homestead application and per-

fect his original entry in the United States land office as is now allowed to settlers under the pre-emption laws to put their claims on record, and his right shall relate back to the date of settlement, the same as if he settled under the pre-emption laws.

Approved May 14, 1880.

Act of June 4th, 1880.

Department of the Interior,
General Land Office,
Washington, D. C., June 4, 1880.

Registers and Receivers of the United States Land Offices in Kansas and Nebraska:

Gentlemen—I call your attention to the provisions of an Act of Congress entitled an act for the relief of certain homestead and pre-emption settlers in Kansas and Nebraska, approved June 4th, 1880, which reads as follows, viz:

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That it shall be lawful for homestead and pre-emption settlers on public lands, or pre-emption settlers upon Indian reservations in the states of Kansas and Nebraska, west of the sixth principal meridian where there has been a loss or failure of crops from unavoidable cause in the year 1879 or 1880, to leave and be absent from said lands until the 1st day of October, 1881, under such rules and regulations as to proof and notice as the commissioner of the general land office may prescribe, and during said absence no adverse rights shall attach to said lands, such settlers being allowed to resume and perfect their settlement as though no such absence had occurred.

Sec. 2. That the time for making final proof and payment by such pre-emptors is hereby extended for one year after the expiration of the term of absence, provided for in the first section of this act; but in cases where the purchase money is by law payable in installments, the first unpaid installment shall be held not to be due until one year after the expiration of the leave of absence aforesaid.

It will be seen that the provisions of this act have reference only to such lands as lie west of the sixth principal meridian in the states of Kansas and Nebraska. Lands in other States or Territories are not referred to, nor are those lands in Kansas and Nebraska which lie east of the sixth principal meridian. The lands to which its provisions apply are included in the land dis-

districts of Wichita, Salina, Concordia, Larned, Kirwin, Wa Keeney, all the districts except Topeka and Independence, in Kansas; and Niobrara, Norfolk, Lincoln, Grand Island, North Platte, Bloomington, and Beatrice, all the districts in Nebraska.

Under the provisions of this act, homestead and pre-emption settlers on the public lands, and pre-emption settlers upon Indian reservations, within the section of country indicated, who have suffered from loss or failure of crops from unavoidable causes, in the years of 1879 or 1880, may leave and be absent from their lands until the first day of October, 1881, without their right to the same being impaired thereby. The pre-emption settlers entitled to its benefits are allowed also an extension of time for making final proof and payment for one year from the first day of October, 1881, and where the purchase money is by law payable in installments. The law provides that the first unpaid installment shall be held not to be due until one year after the expiration of such leave of absence. This right of absence is not available in any case in which there has not been a loss or failure of crops from some unavoidable causes in the year 1879 or 1880. Hence when a settler not actually entitled to the benefits of this act absents himself from his claim it will be liable to be regarded as an abandonment, and adverse claims may be recognized. The settler intending to leave his claim under this act must file with the Register and Receiver of the proper district land office a written notice of his intention to do so, bearing his signature. This is a means of protection to the settlers, and is due to parties who might otherwise make adverse claims. At the date of final proof by any party who shall have availed himself of this act, he must show, by satisfactory proof, the period of absence and specific facts making appear the loss or failure of crops from unavoidable cause, in 1879 or 1880, on account of which he was entitled to its benefits.

The proof should consist of the party's own testimony, corroborated by that of two or more disinterested witnesses.

After a party shall have filed notice with you, under this act, no contest involving his rignt to the land can be instituted prior to the expiration of the legal term of absence to which he is entitled.

If the party should be fraudulently absent it will be a matter for investigation in the regular manner thereafter.

All notices filed you will duly enter on your records.

Very respectfully,

J. A. WILLIAMSON,
Commissioner.

ADDITIONAL RIGHTS TO HOMESTEAD SETTLERS.

An Act to grant additional rights to homestead settlers on public lands within railroad limits:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that from and after the passage of this act, the even sections within the limits of any grant of public lands to any railroad company, or to any military road company, or to any State in aid of any railroad or military road, shall be open to settlers under the homestead laws to the extent of one hundred and sixty acres to each settler, and any person who has, under existing laws, taken a homestead on any even section within the limits of any railroad or military road land grant, and who by existing laws shall have been restricted to eighty acres, may enter under the homestead laws an additional eighty acres adjoining the land embraced in his original entry, if such additional land be subject to entry; or if such person so elect, he may surrender his entry to the United States for cancellation, and thereupon be entitled to enter lands under the homestead laws the same as if the surrendered entry had not been made. And any person so making additional entry of eighty acres, or new entry after the surrender and cancellation of his original entry, shall be permitted so to do without payment of fees and commissions; and the residence and cultivation of such person, upon and of the land embraced in his original entry, shall be considered residence and cultivation for the same length of time upon and of the land embraced in his additional or new entry, and shall be deducted from the five years' residence and cultivation required by law.

Provided, That in no case shall patents issue upon an additional or new homestead entry under said act until the person has actually, and in conformity with the homestead laws, occupied, resided upon and cultivated the land embraced therein at least one year.

Approved March 3d, 1879.

Abstract of land laws passed during the second session 46th Congress, Dec. 1, 1879—June 16, 1880:

CHAP. CCXLIV.—In all cases where it shall, upon due proof being made, appear to the satisfaction of the Secretary of the Interior that innocent parties have paid the fees and commissions and excess payments required upon the location of claims under the act entitled "An act to amend an act entitled 'An act to enable honorably discharged soldiers, and sailors, their widows and orphan children, to acquire homesteads on the public lands of the United States,' and amendments thereto," approved March 3, 1873, and now incorporated in section 2,306 of the Revised Statutes of the United States, which said claims were after such location found to be fraudulent and void, and the entries or locations made thereon canceled, the Secretary of the Interior is authorized to repay to such innocent parties the fees and commissions, and excess payments paid by them, upon the surrender of the receipts issued therefor by the receivers of public moneys, out of any money in the Treasury not otherwise appropriated, and shall be payable out of the appropriation to refund purchase-money on lands erroneously sold by the United States.

SEC. 2. In all cases where homestead or timber culture or desert land entries, or other entries of public lands have heretofore or shall hereafter be canceled for conflict, or where, from any cause, the entry has been erroneously allowed and cannot be confirmed, the Secretary of the Interior shall cause to be repaid to the person who made such entry, or to his heirs or assigns, the fees and commissions, amount of purchase money, and excesses paid upon the same, upon the surrender of the duplicate receipt and the execution of a proper relinquishment of all claims to said lands, whenever such entry shall have been duly canceled by the Commissioner of the General Land Office, and in all cases where parties have paid double-minimum price for land which has afterwards been found not to be within the limits of a railroad land grant, the excess of one dollar and twenty-five cents per acre shall in like manner be repaid to the purchaser thereof, or to his heirs or assigns.

Approved June 16, 1880.

CHAP. CLXIV.—The affidavit required to be made by section 2,262 and 2,301 of the Revised Statutes of the United States, may be made before the clerk of the county court or of any court of record, of the county and State or district and Territory in which the lands are situated; and if said lands are situated in any unorganized county, such affidavit may be made in a similar manner in any adjacent county in the said State or Territory, and the affidavit so made and duly subscribed shall have the

same force and effect as if made before the register or receiver of the proper land district; and the same shall be transmitted by such clerk of the court to the register and receiver with the fee and charges allowed by law.

Approved June 9, 1880.

CHAP. CXXXVI.—In all cases in which parties who regularly initiated claims to the public lands as settlers thereon according to the provisions of the pre-emption or homestead laws, have become insane, or shall hereafter become insane before the expiration of the time during which their residence, cultivation or improvement of the land claims by them is required by law to be continued in order to entitle them to make the proper proof and perfect their claims, it shall be lawful for the required proof and payment to be made for their benefit by any person who may be legally authorized to act for them during their disability, and thereupon their claims shall be confirmed and patented, provided it shall be shown by proof satisfactory to the Commissioner of the General Land Office that the parties complied in good faith with the legal requirements up to the time of their becoming insane, and the requirement in homestead entries of an affidavit of allegiance by the applicant in certain cases as a prerequisite to the issuing of the patents, shall be dispensed with so far as regards such insane parties.

Approved June 8, 1880.

There were surveyed during the fiscal year ending June 30, 1880, 15,699,253 acres of public lands and 65,215 acres of private land claims. The great increase is attributed to the operation of the act of March 31, 1879, which led to a great increase in the number of applications by private individuals for public survey.

Disposals of public lands during the year: Cash entries, 850,700 acres; homestead entries, 6,045,570 acres; timber culture entries, 2,193,184 acres; agricultural series, 1,280 acres; locations with military boundary land warrants, 88,522 acres; swamp lands patented to States, 757,888 acres; lands certified for railroad purposes, 1,157,375 acres. The total area of public lands surveyed from the beginning of surveying operations up to the close of last year is shown to be 752,558,195 acres, leaving the estimated area yet unsurveyed of 1,062,231,727 acres.

Railroad Lands in Nebraska.

Amount of lands of Burlington & Missouri River Railroad in Nebraska unsold January 1st, 1881, by counties:

Counties.	Av'g price.	Acres.	Counties.	Av'g price.	Acres.
Adams	5 00 to 8.00	7,500	Kearney	2.00 to 6.00	8,000
Antelope	1.50 to 6.00	55,000	Lancaster	4.00 to 10.00	33,000
Boone	2.00 to 6.00	67,000	Madison	2.00 to 6.00	47,009
Butler	5.00 to 6.00	500	Otoe	6.00 to 10.00	3,500
Cass	7.00 to 10.00	500	Platte	1.25 to 6.00	8,000
Clay	4.00 to 8.00	2,000	Pierce	1.25 to 6 00	11,000
Cedar	1.25 to 6.00	6,500	Polk	5.00 to 6.00	500
Dakota	1.25 to 6.00	2,500	Saunders	3.00 to 7.00	7,000
Dixon	1.25 to 6.00	6,000	Saline	4.00 to 10.00	8,000
Fillmore	5.00 to 9.00	2,500	Seward	4 00 to 10.00	28,500
Franklin	2.00 to 5.00	65,000	Sherman	1.50 to 5.00	47,000
Gage	5.00 to 8.00	2,000	Stanton	3.00 to 7.00	25,000
Greeley	1.00 to 5.00	83,000	Valley	1.00 to 5.00	70,000
Hamilton	4.00 to 7.00	500	Wayne	1.25 to 6.00	8,000
Howard	2.00 to 4.00	20,500	Webster	2.00 to 5.00	14,000
Jefferson	5.00 to 8.00	2,000	York	4.00 to 8.00	4,000

Estimate of Union Pacific Railway Lands in Nebraska unsold Jan. 1, 1881 by counties:

Name of Co.	No. Acres.	Av. Price per acre	Name of Co.	No Acres.	Av. Price per acre.
Lancaster,	160	12.00	Howard,	47,280	3.00
Cass,	240	8.3	Hall,	39,600	6.00
Sarpy,	440	3.75	Adams,	2,700	7.00
Douglas	1,280	6.25	Kearney,	13,560	4.00
Washington,	4,240	9.00	Buffalo,	140.480	3.50
Cuming,	400	8.00	" Unappraised,	4,000	
Dodge,	5,920	7.50	Sherman,	4,960	2.90
Saunders,	12,640	10.00	Dawson,	121,680	3.50
Butler,	12,740	6.00	" Unappraised,	140,000	
Colfax,	30,240	6.25	Phelps,	55,880	3.50
Platte,	50,240	6.25	Gosper,	10,800	2.50
Polk,	13.880	6.00	" Unappraised,	50,000	
York,	1,800	5.10	Custer, "	83,120	
Clay,	500	5.00	Frontier, "	42,160	
Hamilton,	9,920	6.00	Lincoln,	62,000	2.90
Merrick,	44,120	4.50	" Unappraised,	626,000	
Boone,	2,560	4.25			

Estimate of Government Lands in Nebraska subject to entry at the various Land Offices in the State, Jan. 1, 1881:

Land Office.	Acres.	Land Office.	Acres.
North Platte,	20,000,000	Bloomington,	400,000
Niobrara,	700,000	Lincoln,	——
Norfolk,	300,000	Beatrice,	——
Grand Island,	600,000		

No better indication of the healthy growth of the country, and especially of the Northwest is afforded than the showing for the fiscal year just closed of the business of the General Land Office. The following table affords a comparative statement of the amount of land taken up during the last nine years:

Fiscal year.	Sold for cash—acres.	Timber claims—acres.	Homesteads acres.
1871	1,389,982	....	4,600,326
1872	1,370,320	....	4,671,332
1873	1,626,266	....	3,793,612
1874	1,041,345	803,945	3,518,861
1875	745,061	464,870	2,356,057
1876	640,691	607,984	2,875,909
1877	740,686	520,673	2.178,098
1878	877,555	1,870,434	4,418,334
1879	622,573	2,766,533	5,260,411
1880	1,455,724	2,129,705	6,070,507

It will be seen that the amount of land taken up under the homestead act alone during the year ending June 30, 1880, is far in excess of any previous season. The reasons for this are various, and, among other things, may be traced to increased emigration, the increased price of farm products, and the cessation of Indian hostilities.

Land is being settled faster than the surveys are made, as the following table will show:

Year ending June 30.	Surveyed, acres.	Disposed of, acres.	Year ending June 30.	Surveyed, acres.	Disposed of. acres.
1875	26,077,351	7,070,271	1878	8,041,012	8,686,178
1876	20,271,506	6,524.326	1879	8,455,781	9,333,383
1877	10,847,082	4,849,767	1880	8,500,000	9,657,936

It must be borne in mind that the amount, 9,657,936 acres, does not represent all disposed of this year, but merely that taken under homestead, timber culture, and pre-emption acts.

Nebraska Public Lands.

The aggregate number of acres of lands owned by the State of Nebraska, on the 1st day of December, 1880, was as follows:

Common school lands	2,434,645.51	Agricultural Col. lands	89,452.78
University lands	45,039.93	Internal improvement lands	480.00
Normal lands	12,722.39		
Saline lands	13,285.00		
Penitentiary lands	67,671	Total	2,596,302.32

Statement of the sale and leasing of the common school lands belonging to the State: The number of acres remaining unsold on the 30th of November, 1878, was 1,025,556.78. Number of acres deeded during the years 1879 and 1880, 7,991.60. Number of acres unsold Nov. 29th, 1886, 1,017,565.18. Estimated number of acres of school lands belonging to the State in unorganized counties, and in counties organized but not having a complete record of their lands, 889,729.33. Estimated number of acres of school lands in unorganized territory belonging to the State, 627,360. Number of acres sold at public sale from Nov. 30th, 1878, to Nov. 30th, 1879, 11,741.22. Amount of sales, $88,448.78. Number of acres sold at public sale from Nov. 30th, 1879 to Nov. 30th, 1880, 2,482.03. Amount of sales, $31,055.33. Number of acres purchased by lessees at private sales, from Nov. 30th, 1876 to Nov. 30th, 1880, 16,881.60. Amount of sales, $122,008.20. Number of acres leased during the year 1879, 134,697.04. Value, $572,078.08. Amount leased during the year 1880, 122,843.28 acres. Value, $439,521.17.

Taxes become due the first day of January in eaeh year, and delinquent on the first day ot May, following. After May first, interest at one per cent per month in advance is added, until November 1st, when the land will be offered at public sale, if taxes are not paid.

THE AMOUNT OF LAND TAKEN

each year under the various provisions, including sales for cash, the homestead act, timber-culture act, scrip of various kinds, and military bounty land warrants for the fiscal years respectively within the states and territories indicated.

STATES AND TERRITORIES.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.
Dakota	194,673	251,182	277,986	351,316	205,918	391,645	212,555	1,397 948	1,699,865
Idaho	21,990	14,131	11,260	24,807	24,853	27,219	40,515	84,767	95,982
Iowa	268,290	295,055	91,682	48 571	29,714	22 778	12,227	16,344	10 673
Illinois	5,233	892	2,545	486	555	588	452	4,106	....
Indiana	606	18,432	3,284	332	1,603	507	532	80	....
Kansas	1,488,130	1,383,972	953,183	967 518	575,635	663,786	706,433	1,711 571	2,677,623
Michigan	365,503	526,939	813,040	270,077	226,902	216,502	113,696	127 626	158,521
Minnesota	740,445	576,746	632,519	414,414	347,721	449,586	277,411	958 137	1,028,803
Nebraska	1,041,656	924,533	970,672	643,986	419,200	358,419	255,249	614,773	1,368 445
Wisconsin	394,324	574,671	488,222	341,680	246,401	160,084	121,314	128,996	146,951
Montana	73,478	67,568	25,894	21,368	19,839	28,068	12,688	47,587	87,708
Wyoming	953	4,144	2,619	12,199	7,714	7 487	5,156	23,333	36,231

In the older states it will be observed that the amount of lands disposed of steadily falls off, while in the New States and Territories it rapidly increases.

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